

# The Evolution of Information and Communication Technologies in Organizations

## Some Considerations for the Sector in Argentina

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### Abstract

Since the advent of computers until now, organizations have used the Information and Communication Technologies (ICTs) in many and varied forms. The focus of this work and therefore, its methodology and conclusions, argue that it is possible to identify different stages or steps facing organizations that decide the inclusion of ICTs. If one can know in which stage the company is, it will be useful to know whether or not it should go to the next, or the stage at which it is optimal, given their constraints.

In this paper we develop three different models that explain how organizations deploy ICTs, talking about different stages or parts in this process. There is not an ideal approach, since the same application can be solved in different ways, in different organizations, or at different times in the life of organizations.

**Keywords:** ICT, implementation stages, management, model, organizations, technologies

**JEL:** M15

### 1. Introduction

The acronym refers to the ICT, Information and Communication Technologies, and groups the elements and techniques used in the processing and transmission of information, primarily computer, Internet and telecommunications. ICTs are constituted by the set of resources required to manipulate information and particularly computers, software and networks needed to convert, store, manage, transmit and find.

In recent years, the impact of ICT in different sectors of the economy and in all types of organizations has been impressive, providing a facilitating factor and in turn resulting from globalization. In the words of Kofi Annan (2003), Secretary General of the UN, "Information technology and communication are no panacea or magic formula, but can improve the lives of everyone on the planet. Tools are available to reach the Millennium Development Goals, of instruments that will advance the cause of freedom and democracy, and the means to spread knowledge and facilitate mutual understanding".

In this sense, since the appearance of computers to date, organizations have incorporated ICT in various and sundry ways. So you can find companies that only restrict the use of a personal computer to keep track of their accounting operations with a specific application, other biometric systems that have to control their staff assistance, there are organizations that have automated their administrative processes, and of course there are companies which care systems by generating edge information that help them make decisions at a strategic level in senior management.

Enumerations could continue indefinitely, what is certain is that every organization has incorporated new technologies and computer with their own specificities.

In this context the question arises: Are the processes of incorporating ICTs unique to each type of organization?, or perhaps on the contrary and despite the particularities of each

case may be, are there common standards to analyze the degree development in the integration of ICTs in organizations? It is clear that an affirmative answer to one of these statements implies a negative answer to the other.

If the answer to the first question is yes, it means that every organization implements a methodology for developing information systems in a way that has no points in common or similar cases in connection with another entity. Under this assumption, each case is unique in itself and has no connection with another.

However, while on one hand it is true that each organization chooses its own path when deciding what, how and what limits automate their business processes, management and decision-making, it is considered that it is possible to find similarities or patterns commonalities among various companies when they decide to incorporate new technologies. Clearly it is not the same to use a specific application in an industrial corporation to perform the accounting records that are done in a small business, but surely both face similar challenges, barriers and resistance at the time of its implementation.

Therefore and according to the above, mentioned it is clear that the focus of this work, its methodology and conclusions, argue that it is possible to identify different stages or steps that the organizations decide to include ICTs must face. It is possible to justify on the basis of different studies on the evolution and maturity of the organizations, which identify steps or stages that companies pass along their life. Thus, the organizational maturity curve starts with management systems exist, then with disordered processes that begin to repeat and ordered subsequently documented, communicated, measured and monitored. In this light, we reach an optimum of best practices that can also think from the point of view of ICT, which follow a process of integration of entities itself.

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On this basis, the objective of this paper is to describe different approaches and modalities that incorporate ICTs in organizations, and present some models of their implementation. The importance of this approach is to highlight that it is possible for each stage to identify the benefits, investment requirements, the difficulties faced, among others.

This will serve as a diagnostic tool for a particular entity, regardless of its differentiating features compared to other organizations. Consequently, knowing in what stage the company; it will be useful to know whether or not it should go to next, or the stage at which it is optimal, given their constraints.

## 2. Different Scope and Modalities of Incorporating ICT in Organizations

### 2.1. Some Triggers and Use of ICTs

Following Nelson (1995), we can distinguish three different operations, processes or routines, which are the basis for the incorporation of ICTs, namely:

a) Standard Operating Procedures: These are the ones that refer to repeated operations performed continuously (given its basic character) and very often, resulting in large numbers of transactions or events to be processed and made by individuals usually located in low and eventually medium management of the organization. For example: billing operations, registration, liquidation of assets, etc. Responds to specific needs and referred to the area where the work should be done.

b) Procedures that determinate the process of the investor: These are the ones intended to improve decision-making by management. There are routine processes, involving mostly middle-level managerial segments. May involving one or more areas of the company, they assume the need for a tactical decisions. For example: issuing reports on failures of stock and inventory control, reporting on performance monitoring and uncollectibility dwells within, etc.

c) Procedures which promote an improvement in the activities of the firm: They refer to processes that enable a quantum leap in the company where technology is at the core of culture and organizational management. They are driven by management and have an impact on the entire company. Procedures are strategic. For example: the implementation of an ERP (Enterprise Resource Planning System, Enterprise Resource Planning, composed of a set of standard functional modules that are capable of being adapted to the needs of each company. A way to use the information throughout the organization in key areas such as manufacturing, purchasing, inventory management and supply chain, financial control, human resources management, logistics and distribution, sales, marketing and customer relationship management).

The different processes described before act as triggers of different information needs of each of the areas and / or users involved.

In the organization, ICTs can be implemented with any of the following uses (Farré, 2009):

a) To develop or to buy special software, to respond to the requirements of a particular area of the company without integrating it into other business applications (sometimes this lack of connection can be up in the same area). An example of this would be a Human Resources Department that has a special software to settle the salaries of their employees while a biometric attendance control, issuing a report with the hours worked. In turn, an administrative worker manually loads those

hours in a salary system to determine the base pay to settle. In this case, the ideal would be that both systems could be integrated to streamline the process (to avoid loading errors, speed in the settlement, etc.).

b) To list all applications to achieve an integrated system. In these cases, the company focuses its attention on the needs in terms of processes and no areas or departments that comprise it. Therefore, one must first identify the key processes or major company, and then consider interference areas with analyzing the needs of different users throughout the organization. An example of this would be a system that controls the flow of material which is sent to output, interacting with the area of deposit. The application can also relate and generate output reports in Accounting register to production costs depending on the material flow. Similarly, one can think of a link with customer applications (to let you know that your order is ready) or suppliers (to send a note to buy or budget).

c) To redesign the architecture of all databases that are created in different applications in the enterprise. There are larger databases and with common characteristics to the different applications that the company has. In this way, it means moving from web architecture to a data warehouse. This implies that the company must tackle the development itself of all its applications, defining policies and protocols for construction, defining scope and access profiles, users, etc. An example is the case of the "Sistema de Información Universitario" (SIU), built by a consortium of universities in Argentina, which has developed applications ("Guarani", "Pilagá", "Mapuche", "Toba", etc.), in order to manage the information systems of the "Sistema Universitario Argentino" (SUA). These applications are designed for each management area of the academic units whose databases are concentrated in order to be consulted by the system 03 Data Warehouse (DW 03).

d) To generate reports and processes that help decision makers to have elements of decision and management rules that substantially improve management of the company. This can be done by means of scientific applications (e.g. SPAD, R Commander, SPSS, CAD, etc.). An example would be, by applying mathematical and statistical models, infer the pattern and consumption behavior of customers. According to that, management can face decision to introduce elements that help to categorize when thinking about selling strategies by differentiated strata of customers. In this case the decision-making remains under manager's control, but it is impossible for him to realize the potential relationships between products sold and customer preferences. Given the large volume of data that information can not easily be related. But with the help of these scientific applications you can find the necessary relation, with the help of the programmer that introduce such rules in the application module customer sales, and to issue a report where you can see the status of each one of them, and participation on sales.

e) To give the system active and direct interference in the role of decision making. It refers to systems that replace the person who makes decision. By way of example may be cited the case of a system that anticipates failure in inventory, place your order product suppliers, choose what is the most convenient to shop and asks the financial manager to release the payment (or automatically issues bank transfer).

However, regardless of these different uses, not all organizations are necessarily satisfied with information systems they have, may be some others may think they have a good system

but in fact this is not true, we also find companies that want to increase the use of ICTs and fail, and paradoxically perhaps others succeed with equal or less resources.

In short, each organization depending on characteristics peculiar to it, must choose the most appropriate and efficient use. In this regard and in relation to the implementation and / or redesign of information systems of the company, "not all roads lead to Rome". Two companies of similar size in the same industry or activity that want to implement a system, not necessarily get the same results. This is where you have to stop and ask: What aspects or limitations should be considered when trying to incorporate ICT in the organization? How to overcome these barriers if they all can be transferred? What aspects should be considered as enhancers or facilitators to the implementation of these technologies? Considering budget constraints, staff training, management vision, is it appropriate to deepen the development of a new system? How to tell if you are in a rational and optimum use of ICT in the business?

## **2.2. Factors that Positively and Negatively Affect the Process of Incorporation of ICTs**

For each type of organization in particular, there are factors or conditions that drive or stop, even reverse, the process of incorporation of ICTs. It would be naive to think that the journey made by companies from purchasing their first computer until the design of a business-intelligence system, is free of ups and downs, and that always occurs upstream.

Among the factors that encourage incorporation of ICTs and following the arguments of Peirano & Suarez (2005), which called "economies of computerization", we can mention:

a) Process Automation: Organizations implement new automation technologies that quickly produce a perceptible effect on the efficiency of processes such as: speed in processing times, reduced transaction errors, calculation, or recording, etc.

b) Access to information: The almost inexhaustible ability of computers to process information and the possibility of incorporating processes of searching, sorting, selection, summarization, to generate reports and make projections, repositions the role of managers because they now have more information. Depending on how advanced the enterprise system is they can access all that information and make decisions without even being inside the company. Access breaks the barrier of not only geographical boundaries but temporary, because it can be accessed information regarding historical series as well as make projections based on different scenarios. We can process millions of data in seconds into information.

c) Facilitation of innovation and learning processes: Every time a company has in its hands the opportunity to develop an application or implement a new model of ICT in their organization, it presents a good opportunity to think about best practices and procedures to make progress in management. A good teamwork, interdisciplinary, that enhances creativity and innovation. Moreover, implementation processes lead to create spaces for debate that result in a review of objectives and needs of those involved. This critical thinking exercises results in a significant improvement for organization.

d) Reduction of transaction costs: Regardless of degree of development that has information system, the reduction of transaction costs is often from the most basic stages or initial use to those in which ICTs are embedded in the processes management. For example, enter an application to calculate the wages to be paid into a company of over 500 employees, will

surely impact the number of employees who were assigned to do this task manually in the Human Resources Department. In turn, reducing calculation errors, omissions, etc., its effects will also lower the costs of bureaucracy. Similarly, an organization that has a system that automatically sends purchase orders and quotes via email provides causes a decrease in communication costs previously done by fax, telephone, mail, or even by a cadet company. A system that is always aware of possible missing, also affects a significant improvement in the reduction of inventory costs break.

Now, just as there are factors that encourage the use of ICT, we can find others who act as inhibitors. Following Farré (2009), we can mention among them:

a) Budget Constraints: All companies spend implicitly or explicitly, resources for the implementation of new technologies. It happens that at the beginning, when the organization began to introduce a couple of computers timidly, the initial investment is negligible. However, if you need to develop an integrated system, the costs associated with this project clearly appear as significant.

b) Human Resources: To introduce ICTs in organizations never has a neutral effect. At the operational level is where workers most feel the impact of automation functions. The efficiency gains require the reallocation of existing staff or reduction. We agree with Gibson and Nolan (1974) when they state that management can not make a mistake of assuring employees that the technology implementation will have no effect on his work. Be aware that a rejection can occur naturally or be denied by some employees to use these technologies. Another aspect that can be understood as limiting is the quality of human resources that the company owns. The greater is the integration of smart technologies and integrated into the business, the greater will be the need for trained people to be part of these projects. There is no point in having the best system on the market and available funds to implement if people do not fall short and can not take advantage of all the functionality and potential of the system.

c) User expectations: The needs of a production manager are not the same as of an employee who settles more than 250 monthly salaries. The different needs of users give its own stamp on the solutions that we seek to provide the organization with the system. In general, people at the base of the organization seek solutions to address specific questions about their work and want it quickly. Instead, a midlevel manager is not so interested in how to enter data, but to analyze and generate reports to make decisions more rationally.

d) Time factor: Some organizations may not have financial constraints to begin development of a new system or may have the personnel involved to address the new project, but lack the time to do it. For example, implementation of a SAP system usually requires more than a year. Therefore, the lower the time available, attempt against the most sophisticated solutions.

To conclude this section we can say that depending on the relative weight of these factors are enhancers and inhibitors, that is, depending on the inherent characteristics of each organization, the result of the incorporation of ICT and its use may be a success or a failure. It is the history of the organization, its configuration, its organizational culture, the vision of its management, human resources, etc., the ending or anchoring enhancing the likelihood of success on projects of this nature.



### 3. Models of ICT Implementation

#### 3.1. Introduction

So far we have seen how organizations appropriate the technologies, giving a particular purpose, distinctive from the rest. However, at the beginning of this work, it was considered that it is possible to find similarities or common patterns among various companies when they decide to incorporate new technologies. And if this premise is true, then it is possible to assess at what stage or level of development the company is, and thus check which aspects should be given if you will consolidate the position or advance to a higher stage.

As we discussed in the introduction to this work, organizations go through different stages in their life to achieve organizational maturity, and ICT accompany that process in a particular way, with its own cycle of joining the organization. ICTs affect the strategic situation of the organizations, becoming a more competitive variable, altering its efficiency, operational costs and response time to any changes. In an optimal stage in which the organization is implementing organizational standards and best practices, the recruitment and development of these technologies is fundamental.

Next we make a brief description of the main models presented by experts in the field, related to the implementation of ICT, which as noted earlier shows a cycle that integrates itself in the organizational stages.

Linked to this is an important concept called lifecycle systems development, and life cycle of software development (SDLC for its acronym in English), pertaining to systems engineering or software engineering. It refers to the process of creating or modifying systems, models and methodologies used to develop different software systems. The SDLC is a logical process used by a systems analyst to develop an information system, which also refers to different stages or steps.

#### 3.2. The Model of Gibson & Nolan (1974)

These authors presented a model that is very useful for analyzing the degree of development of the implementation process of ICT. Their work is aimed at large for companies (corporations) and proposes four stages in the development of a department of electronic data processing. The above four stages are: initiation, expansion, formalization and maturity. The following briefly describes each of them:

a) Introduction: The computer is used for the first time. Management is not aware of the importance that their introduction will have in the future of the company. Generally the computer is installed in the area of Finance and Accounting. The authors note that this will bring problems in the future when the company decides to create a Systems department as power conflicts arise between different areas. Employees may express their fear and resistance to the use of computers. The control and responsibility for resource management is left to the department where the computer is housed.

b) Expansion: The use of computers is extended to other areas and in each area, there are different applications to solve local processes. It then produces a contagious effect because other departments perceive the benefits of automation tasks. The costs soar because each area not only demands but also requires more equipment to hire people trained to develop their solutions and / or buy new software. There is a climate of euphoria and optimism in the use of ICTs. Initially management accompanies this process until it warns that funding for these

activities are growing at a faster pace. The stage ends when management realizes that they must begin to centralize and organize everything related harmoniously to ICTs.

c) Formalization: Top management focuses its efforts in monitoring all activities. The “letting go” of stage 1 and 2 is far behind. The management assumes a more active role. In terms of human resources, several effects are noticed. More innovative “developers” may feel overwhelmed by the change of management to control most obvious and tend to leave the company. Functions are re-allocated, in a more comprehensive thinking about the development of the entire company rather than a sector or department. The systems department managers begin to have input in decision making. Management begins to think in more sophisticated systems.

d) Maturity: The Corporation has achieved the highest level of development. The systems department managers are full members of senior management. There are major pitfalls along the way.

#### 3.3. The Model of Peirano & Suárez (2005)

Unlike earlier, this model was developed to analyze how SMEs improve their performance by the introduction of ICTs. The authors identify three distinct stages for them in this process which are detailed below:

a) Generation and Records Management in the company: At this stage there is overlap with the initiation stage model of Gibson & Nolan (1974), as well argue that this stage usually begins when you decide to automate standard operating procedures of the accounting area with few investments for this purpose. While use is limited, improvement produces a significant leap in the automation of the processes involved. Another aspect is that the inclusion of technology at this level does not require special skills or high score on the staff concerned.

b) Information Analysis: One of the most indicative signs that the company has entered this stage is related to the appearance of reports where it shows a clear intention to explore the data to find relationships and support criteria used for a decision. Thus began a stage where it expands the use of the computer, it requires more trained personnel and special abilities. Managers center their demands to transform large volumes of data into a table format, graphics, series, etc., enabling them to analyze the situation of the company and make strategic decisions. The budget grows exponentially faster than in the previous stage.

c) The interactive and cooperative work: The starting point of this distinctive new stage of development is the emergence of intranet that allows linking different applications, allowing information stops flowing in one direction, to flow more openly by all organization. The resources affected at this stage are considerably higher than in the previous stage, especially if the company is committed to research and development projects.

#### 3.4. Farré model (2009)

This model analyzes the different roles that can take information systems in organizations. Unlike the previous two models, it does not limit the analysis to large companies or corporations as they do Gibson & Nolan (1974), nor focuses only on small and medium enterprises as the model of Peirano & Suárez (2005). It may be inferred that the author emphasizes the role of the different applications in an organization and its relationship to the decision-making process. The model is based on the premise that the computer can participate more or

less actively in the life of a company, according to the way you designed the Information System. How to define and implement the system determines the role that it will enforce, which can be informative or asset management. These three roles that ICT can assume are detailed below:

a) Informational Role: The computer is used to automate a task. It involves a redesign of procedures because the machine does what a person was doing before. The inputs and outputs of these applications are similar to those obtained by the above procedures. In this context, systems have no interest in making decisions; they only process data to provide operational information. Its implementation affects the lower levels of the organization. You can have separate application architecture in each area or an integrated system. There is an administrative automation.

In this role it may be that each application manages its own data, producing redundancy, sealed enclosures, and inconsistencies in the criteria or the update status of common data. There are applications related to each other to overcome these problems, and would not be in the presence of a separate application but within a framework that can be referred to the total system processing information. It says here that there is integration, and that while the computer continues to play an informative role, information is shared and seeks to resolve common problems through the development of unique applications.

Something what should be noted is that the introduction of computers impact in different organizational and employment aspects, including:

- Human resources: in this case the worker will change the way of doing things, must learn to operate a computer, and may be afraid of losing its jobs (which can generate resistance to change).

- Efficiency and accuracy: that will significantly increase as it gives greater prominence to the computer, since the tasks are performed in less time and be more accurate calculations. You can also use the workers considered released in other functions.

- Organizational structure: it can be changed, especially if you opt for integration, as it established new relationships and communication between areas.

- Monetary costs: Among others may be mentioned the development of the new system, staff training (if required) and any severance pay.

- Information sharing: In the case of opting for integration, there might be some conflicts in regard to privacy of the information handled by each area, so it must be designed very carefully the matters relating to access.

b) Directing Role: middle and / or high managers face growing volumes of information. This hinders their analysis to design models that endorse management decisions. So, the information is presented differently and the computer is not only informative but fulfills a role that guides or directs the process of decision making. This is achieved by generating decision elements through special programs. These elements or criteria issued permit ICTs reports to facilitate the task of the manager. On a broader level, it can also be generated decision criteria that are incorporated into the application to have a larger role in decision-making.

As for the impact on the organization, the greater is the computer's role helping make decisions, and higher education levels are more affected by fear of losing his job. There are changes in working methods, now the employee or the

manager simply has to confirm or overturn a decision that the computer offers. Thus, generally are human problems and the organizational structure that slow evolution.

It can also be expected cost savings (or increased profit) derived from a more scientific, to the extent that better information will lead to better decisions.

c) Active Role: Unlike earlier, at this stage the computer can replace the person who makes decisions, in the leadership role guiding systems for decision-making. But at this stage, it makes decisions for them. Obviously this is only possible if the decision rules defined in the system is verified and validated previously. It is management automation.

In addition to the organizational and labor impacted as described above for the other two approaches, the Department must consider here the issue of security. There are situations where it is desirable to delegate decisions computer.

### 3.5. Model Comparison

Below there is a table comparing the three models described earlier: *Figure 1*

In synthesis, the importance of these three models lies primarily in the possibility offered to analyze what the situation is regarding an organization implementing ICT. Besides its usefulness for conducting preliminary diagnosis, it also allows envision that are the main things to consider if you want to move forward and deepen the integration of these technologies.

From integration perspective can take those elements of each of the models that best explain reality, because in actual fact, the three are complementary.

## 4. Some Data Relating to ICTs in Argentina

Given the increasing importance that innovation activities have gained in the development process of countries like Argentina and the importance of correct measurement of the efforts made and the results that matter, the "Instituto Nacional de Estadísticas y Censos" (INDEC) has decided to draw on an annual "Encuesta Nacional sobre Innovación y Conducta Tecnológica" (ENIT) aimed at industrial enterprises.

The information here is for the survey referred to the period 2005. Thus continues the series started in 1997 with the First Technology Survey 1992-1996 that followed the reports on the periods 1998-2001 and 2002-2004.

In terms of the report, the year 2005 is a period of strong growth for industrial and deepening their innovative efforts. You can also become evident that the performance of ICT companies this process.

Panel Companies for 2005 shows positive developments in ICT, as have increases both firms which invest in ICT, as well as significantly firms decided to form a specific area of ICT.

The proportion of companies that make efforts in ICT grows with increasing the size of the company, being consistent with the early stages of the models described in the previous sections. Thus, the distribution of sample size efforts shows that larger firms have the largest investments made in 2005.

Moreover, it is significant to note the wide gap observed between efforts from small businesses regarding the efforts of larger companies. Analyzing the structure of expenditure by size of company, it can be seen that, in the acquisition of machinery and equipment the highest proportion engaged in this type of investment are small businesses (74.5%). Furthermore, and according to data from the sample, while 92.2% of large

**Figure 1 - Comparison Models**

Source: Own

Category	Model		
	Gibson & Nolan (1974)	Peirano & Suárez (2005)	Farré (2009)
Organizations considered	Corporations	Small and Medium	All
Stages	Four	Three	Three
Emphasis	Systems Department Role	Improving performance by use of ICT	Role of information systems
Aspects analyzed	Growth of the applications, staff expertise, management focus	Routines (application complexity), evidence of the impact on performance, investment and savings computerization	Predominant processes, types of inputs and outputs, role in decision making, impact on the organization structure

companies invested in ICT over the last year, small businesses invested 32.9%. Similarly, while 94.6% of large companies invested a specific area of ICT, only 48.7% of small feature it.

Companies that invested in ICT decide to accompany this effort largely specific training for staff (62.4%) and with organizational changes and working method within the company (52.4%). These investments included for 2005 software development or system (57.7%) and adaptation of standard software (56.9%) to a greater extent than in the previous year. Both the development and adaptation of software were mainly in charge of the company's own staff and suppliers.

The use of Internet-related tools is no longer a differentiating factor and has become a staple for the operation of industrial enterprises. Very few companies in the sample did not end in 2005 with an Internet connection.

However, it is important to highlight the evolution presented by electronic commerce, in the course of recent years has left strong growth seen rising from 14.6% in 2001 to a level of 43.3% in the year 2005.

## 5. Conclusion

This paper has presented a brief development on how organizations incorporate ICT in their various processes. We analyzed the different modes and methods presented in different organizations. Subsequently, we described the main factors that encourage or inhibit the development of these technologies, giving some examples for further illustration.

Based on expert opinion, three different models were developed to explain how organizations deploy ICTs. In this sense, we studied the models of Gibson & Nolan (1974), Peirano & Suárez (2005) and Farré (2009), presenting its main features.

As stated, the importance of these models is given, on the one hand, by the great usefulness for diagnosing the status of

the organization, as far as ICT implementation concerns and on the other hand, because of its predictive regarding the advantages or disadvantages of further progress to the next stage.

In this regard, you should always evaluate the benefit of moving from one stage to another against the cost of doing so. And this depends on the organization, the activity, the time of life cycle in which it is the business, staffing, etc. Therefore, it can be said that there is not an ideal approach, since the same application can be solved in different ways in different organizations or at different times in the life of organizations.

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