

INTERACTIONS BETWEEN INFORMATION TECHNOLOGIES AND THE ORGANIZATION: A CONCEPTUAL AND EMPIRICAL APPROACH.

AUTHORS: **Alejandro Orero Giménez.**
Carlos Suárez Rey.

Organizational Engineering Group. E.T.S.I.T. Universidad Politécnica Madrid.
¡Error!No se encuentra el origen de la referencia.
¡Error!No se encuentra el origen de la referencia.

SUMMARY

This article presents the main aspects about the interactions between Information and Communication Technologies (I.T) and the Organization. The interaction is analysed through the Information and Communication Systems (I.S), and its relations with different elements of the organization.

A preliminary conceptual analysis of information and information systems will be presented, covering aspects such as structure, and processes developed by the system. To analyse the possible interactions between the organization and its information system, several known interaction models will be revised. First we will present the Scott Morton (modified by Orero et al.) as an integrated model. In second place we look at two strategic models; the Organizational Fit Framework (OFF) proposed by Earl (1996) and the Strategic Alignment Model proposed by Henderson and Venkatraman (1989, 1993).

All the models revised belong to the category of “interaction models”; with an static view of the interaction. This study also analyses some contributions to add a change process (dynamic dimension), presenting the Silver et al model (1994) or the change model proposed by Orero and Suárez in a recent research study.

In addition, some results from an empirical study of 50 medium size companies will be presented, showing the main conclusions about the different interactions between the organization and its information system, as an empirical contrast of our conceptual model.

The results obtained will be useful to reach conclusions, that can suppose a step forward for the investigation on an aspect which has become a key factor for organization competitiveness; maybe the most important at this moment: “the improvement in the management of the information and the knowledge in organizations”.

INTRODUCTION

As Drucker says (1993), a silent revolution is taking place in the society, where the economic basic resource is not the capital, natural resources or labour; the basic resource is now and will be the knowledge. “Now the value is created by productivity and innovation, both applications of knowledge to work”.

Near the end of the twentieth century, enterprises face new challenges to maintain their competitive position. To compete in cost or provide high quality products or services is not enough. Organizations are undergoing deep changing times in an information and knowledge society where innovation and continuous learning become the basis to new game rules. The challenges mentioned above are making organizations to introduce large changes, for which the Information System role can be one of the keys to success.

Until the eighties, Information Systems was considered to be an element which could provide economies in the internal costs, as it could support operative activities in which the information was the main involved element. Nowadays the information system is considered to be the key to the development of new products and services, and is the main support in the managerial work (a special remark must be done with regard to decision making). It allows to co-ordinate the work within and between organizations and it mainly allows to improve company procedures by designing truly information oriented organizations.

Information Technologies provide new tools for organizational design, as it has been pointed out, providing at the same time new management procedures, new strategies and new values. Nevertheless, the limitative factor to improve information system is not usually found in technological aspects, but in the organizational ones, where changes are more difficult to implement.

In this context, our research work intends to serve as a contribution to the design of methodological tools, adequate to introduce changes in an organization, taking into consideration both aspects; organizational and technological.

INFORMATION AND INFORMATION SYSTEMS IN ORGANIZATIONS: CONCEPTS AND DEFINITIONS

The term “information” is part of the common language, and is widely used in a variety of situations and with different meanings. Since we are dealing with the management of information and information systems in organizations, it’s important to present and define the concept proposed by the authors, for a better understanding of the remaining part of this study.

“Information is for a given person, each signal, each message, each perception able to produce an effect on his behaviour or his knowledge level”. In other words, we understand that information is all that can be learnt and allows to increase our knowledge, reducing uncertainty. It is therefore a requirement for decision making.

It is important to distinguish the concepts “information” and “data”. Data is the representation of some attributes of an object or fact (i.e. the size, the cost, date, etc.). Information is the result of the analysis, treatment and presentation of data for a given person or group. Data alone have no meaning. Data need to be presented in an useful way and an appropriate context, to create some value to an specific user. When this value is created, we consider that data has become information for a given person or group. The data is therefore the raw material for the information.

Experience and research work in the information field has proved that good information must have the following characteristics: relevant for the specific concern, accurate, complete, from a reliable source for the user, handled to the adequate person, provided on time to be used, with the adequate level of detail, communicated through the appropriate channel and understandable for the user (Orero and Suárez, 1997).

On the other hand, “system” is in a wide sense a set of components that interact to meet some objective. This concept can be applied to any organization, obtaining different levels of subsystems. The Information System is one of the critical subsystems for any organization nowadays.

An information system can be defined (Checkland, 1981) as a set of procedures aimed to organize the information flows, and the related equipment. According to this definition, the “set of procedures” include not only the structured and formalised ones but the informal, that are of critical importance for understanding the information system of any organization.

Andreu, Ricart and Valor (1994) propose a more formal definition of an information system; “set of procedures that operate on data structures following the specific needs of a given organization and collects, processes and distributes the information needed for the operations in the organization, as well as for management and control”

Most definitions consider the main aspects of any information system, making by general rule more emphasis on some of them. These aspects include:

- The objective of the information system, aligned with the objective of the organization.
- The structure and components of the subsystem; including both the organizational components (people, procedures, rules, values...) and the technical components (information technologies mainly).
- The information management processes; typically, input-process-output.

With regard to this last aspect of the definition, we consider that the information system should provide useful information, that can add value to the organization. Taking this into consideration, we have included two additional processes to the typical input-process-output model: the definition of information needs, and the real utilisation of the information provided by the system. This is presented in figure 1.

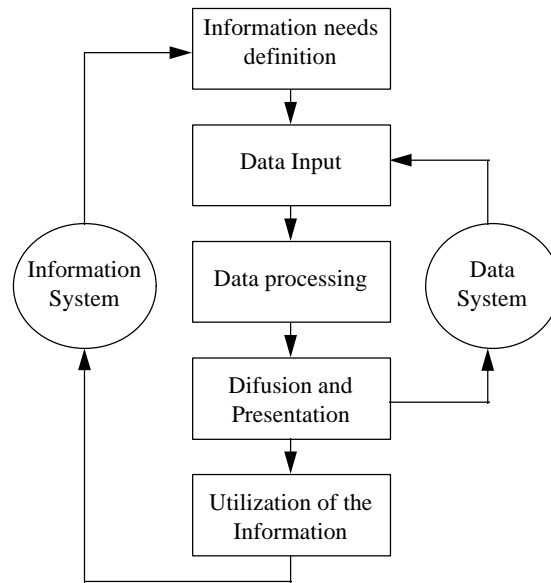


Figure 1. Processes of an Information System. (Source: Orero and Suárez, 1997)

In figure 2, we present a model that describes the processes carried out within an information system. In the model we have identified two groups of phases and the related agents (users). The first group of phases (that can be named operative or transactional) are more easily automated and they are the main area of application for information and communication technologies, I.T (data input, data processing and communication and diffusion). The second group has to do with “knowledge activities”, of users of information and knowledge (agents of the previous phases). In an information system without I.T, all the phases would be performed by people (traditional office).

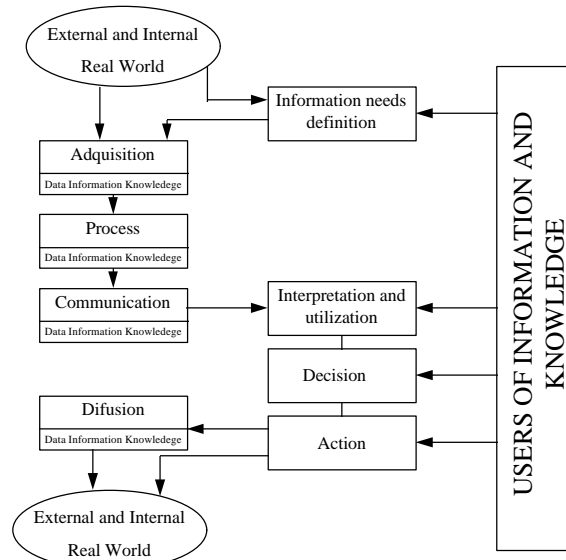


Figure 2: Process model of the organization information system.

Independently of the definition considered, the information system plays a critical role in any organization as a basic support to all the processes where information is the main involved element, including both, the operations and the decision making processes.

STUDY OF THE INTERACTION BETWEEN THE INFORMATION SYSTEM AND THE ORGANIZATION

The interaction between the organization elements and the information system is one of the main investigation fields at this moment. The research works are normally included within one of the following categories:

- Integrated models of the complete interaction. Most studies show the existence of two different dimensions that affect the interaction between the information system and the organization: the strategic dimension and the organizational dimension.
- Analysis of the Strategic dimension of the interaction.
- Analysis of the Organizational dimension of the interaction.

In this article, we present our contribution to the integrated interaction model, based on the Scott-Morton model (1991). We also introduce the main aspects concerning the two dimensions of the model.

The article also compares two models more centred in the strategic dimension of the interaction; the Organizational Fit Framework (Earl, 1996) and the Strategic Alignment Model (Henderson and Venkatraman, 1994).

Finally we will present some contributions to the integrated model study, proposing the introduction of a change process to the model (time-dimension variable). We will present the Silver et al. model (1994) and a recent study presented by Orero and Suárez (1997).

The Interaction Model

The consideration of the interrelations between the different dimensions of the organization; its strategy, structure, processes, culture, etc., and the information systems and technologies is a basic aspect that requires an equilibrium to meet the most important objective of the information system; that is to support the objectives of the organization. A representation of these interactions is presented in figure 3., that shows a modified version of the Scott-Morton model.

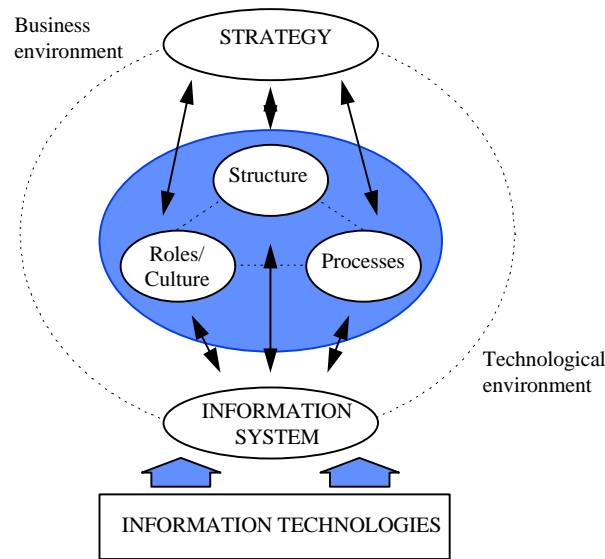


Figure 3: The Information System Interaction model. (Source: Scott-Morton, modified by Orero et al.)

Each of the bi-directional arrows in figure 3 is associated to one of the dimensions of the interaction. The specific analysis of each of them is out of the scope of this article, although is part of our investigation areas at this moment.

The modified model considers the information system as the interaction element with the organization; the information technologies are considered as a component or a support for the information system. Therefore, the model also considers the effects of information on the different aspects of the organization, independently of the technological supports.

We shall consider the existence of several approaches in the study of the interaction. Orero (1995) identifies the approaches oriented to the results of the interaction and the approaches oriented to the interaction processes.

Organizational Dimension of the interaction model

Although the strategic potential of I.S/IT is clear for most authors, there isn't a complete agreement on the effects that the introduction of I.S/I.T produces at an organizational level; i.e. how the introduction of I.S/I.T can modify the structure, processes and culture of an organization. Nevertheless, there is no doubt about the impact of Information Systems and Technologies in today organizations. Information Technologies have made possible the existence of new organizational models with names directly derived from the support technologies used: network organizations, inter-organizational alliances, distributed organizations, knowledge based organizations, etc. Many authors had anticipated this kind of organizations even before the support technologies were available (Leavitt, Wishler 1958). Certainly, in the 1990's, models of organizations carry labels which represent a convergence of information management and organizational theory.

There are multiple points of view about the relation of the information systems and the organizations. The information systems authors indicate that information systems have modified and will modify in the future the structure, processes and culture in organizations.

Our model, based on the Scott-Morton model, is based on the earlier ideas of Leavitt (1964), who related the main organizational elements; structure, processes, culture and technologies. For this author, any change on one of these elements must take into account the induced change in the others, since they are mutually affected. The term “technology”, is now referred to as Information Technologies, but the concept is based on the Leavitt model of more than 3 decades time.

Three main reasons explain the complexity of the relations between I.T and Organization:

- The interaction between I.T and Organization presents a great variety of possible perspectives.
- The introduction of I.T in the organization often occurs simultaneously with other kind of changes.
- The introduction of I.T in the organization is not produced in a fixed moment, but a period of time. During this period, many variables change, and this must be considered to understand the interaction.

Based on the works of Sampler (1996), we have proposed a model for analysing the interaction of I.S/I.T with the organization internal elements. Our model suggests to consider the different interactions with structure, processes and culture, taking into account some variables:

- The organizational unit for which the analysis is being carried out. According to this, the influence of I.T can vary from one to other organizational units; departments, divisions, locations, and so on.
- Perform the analysis process by process; considering that the influence of I.S/I.T can be different for each process. For instance, the influence of I.T can be very different for the administrative processes or for primary processes (value processes in the value chain of an organization).
- Consider the impact of different I.T; for instance multimedia, data base, decision support software, etc.
- Consider the variable time, to conclude about the result and nature of the interaction. In this sense, we introduce in the model a perspective of the earlier evolutive models (See Nolan and Gibson, 1974 and Ward-Griffiths, 1996).

The previous ideas, show that the interaction of I.S/I.T with the organization is complex and can not be treated monolithically. Our empirical study has proved the importance of these variables for the analysis, with great differences in the results obtained.

Strategic Dimension of the interaction model

One of the dimensions of the proposed model (figure 3) is the strategic dimension. It is important at this point to clarify a term that implies one of the differences in the proposed model. We refer to the

terms I.T and I.S. The influence of I.T in the organization is not produced directly; this influence is the consequence of changes introduced in the I.S.

We must therefore analyse the interactions between the I.S and the strategy. But we also must study the I.S strategy, and I.T. strategy, producing a hierarchy of strategic subjects.

Many authors have studied the strategic role of Information Systems and Technologies during the last two decades. Earl (1988) presents an analytical study of the existing frameworks to characterise the relation between strategy and I.S/I.T. These models can be grouped as follows:

- Knowledge or sensitization models; aimed to describe the present situation of an organization with regard to the strategic use of Information Technologies. They are generalist models useful for academic purposes mainly. Examples of these models would be: Benjamin et al (1984), Parsons (1983), Porter-Millar (1985).
- Opportunity models, aimed to present potential opportunities for strategic applications of I.S/I.T. Within this category fall the Porter value chain model or the Wiseman strategic model (1985). The strategic opportunities proposed by most authors are:

Systems that affect the added value process of an organization.

Systems that allow to produce, or deliver information based products.

Systems that allow to share information with customers and suppliers.

Systems that improve decision making.

- Positioning models, aimed to measure the strategic use of I.T in an organization. An example of this kind of model is the strategic matrix of MacFarlan.

Comparison of two Strategic Integration models

All the strategic worries of an organization about I.T are related with the achievement of strategic vantages through the use of them and how to align the I.T strategy with the organization strategy. It is also of critical importance to worry about the I.S strategy and organization policies. These relations are well explained in the Organizational Fit Framework OFF (Earl, 1996), or in the Strategic Alignment Model SAM (Henderson and Venkatraman, 1994).

These models can be considered as “integrated strategic models or strategic alignment models” that would include part of the aspects covered by each of the different types of strategic models presented in the previous section.

The OFF model presents four interrelated domains (see figure 4); the organization strategy, the information system strategy, the information management strategy and information technology strategy. The objective of this model is to provide an integration mechanism of all information resources of an organization, providing a way for the strategic direction of I.T.

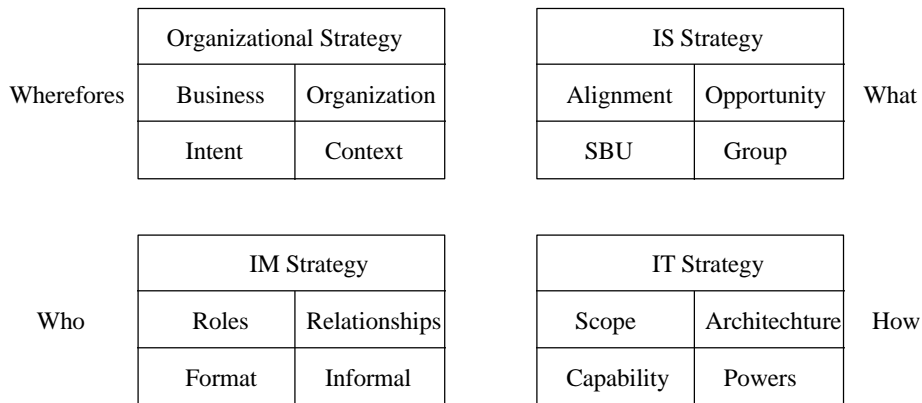


Figure 4: Integration of Organization and Information System strategies. Source: Earl, M. (1996)

The OFF model allows to integrate the I.T into the organization through the I.S, in the same way as it was proposed in the equilibrium model (Scott-Morton modified by Orero et al). Earl (1996) suggests that this integration is performed through interaction processes. The existence of these interaction processes breaks the classical hierarchical orientation. However there are two possible situations; the “wagon effect”, where the strategic level is followed, beginning from the strategy of the organization. The other orientation considers the strategies related with information (I.T, I.S and I.M) as the basis for gaining competitive advantages “motor effect”.

Earl analyses the different interaction processes; the influence process of organizational strategy over the rest of strategies is named “clarification”. The influence process of I.S strategy over the rest is named “innovation”. The I.T strategy affects the others through a process named “foundation”. Finally the Information Management (I.M) strategy acts over the rest strategies through the “constitution process”. The constitution process is related to the way in which the I.S function is directed. This aspect has been identified (See Orero and Suárez, 1997) as a third dimension of the Scott-Morton modified model. In this work we present this aspect for organizational change through the use of I.S/I.T, as will be described later.

The SAM model (Henderson and Venkatraman, 1994) also considers four domains; business strategy, organizational structure and processes, I.T strategy, and I.T structure and processes. There are several similarities and differences with respect to the OFF model. The SAM model reflects a more academical perspective. On the other hand only two of the four dimensions can be considered strategic. The main contribution of SAM model is mainly the strategic integration between the external (business and I.T strategies) and internal environments (organizational and technological structures and processes).

The change process

The objective of our model is to identify potential areas of organizational change to improve the organization position. The situation is represented graphically in figure 5. However, the models presented in the last section lack of this dynamic perspective, and therefore they have a limitation to be used as change tools.

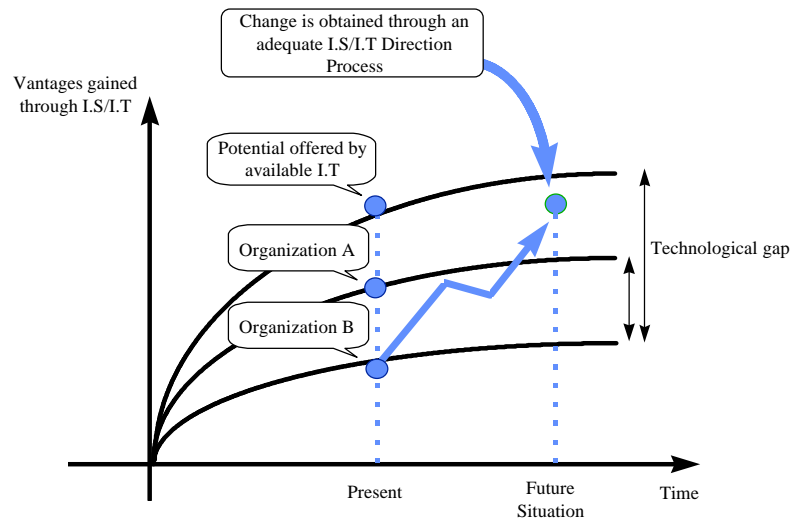


Figure 5: The Direction of I.S/I.T as the key factor to improve the organization through the introduction of I.S/ I.T.
(Source: Authors)

The Silver model (1994), takes into account the time variable, introducing the concept of “Implementation Process”, parallelly to an organization model, very similar to the Scott-Morton modified model. In the Silver model the I.S is used as a change agent and it is considered as an essential component of the organization.

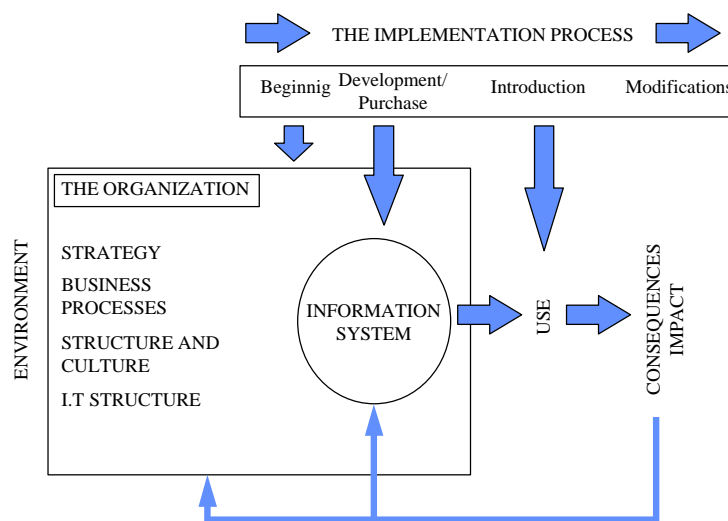


Figure 6: Interaction model by Silver et al (1994) The model introduce a change process named the implementation process.

Orero and Suárez (1997) have proposed a third dimension to the Scott-Morton modified model, introducing a change process. The change process identified by the authors, includes the implementation process proposed by Silver, as one of the phases. In addition to this “implementation process”, our model also includes the cultural aspects and strategic alignment aspects of change, including the “actors” involved in each process. The change process is named “I.S Direction Process” (see figure 7), and considers two dimensions: the involved people and the

related processes necessary to introduce the I.S/I.T in the organization. The empirical work performed on 50 organizations, has proved this aspect to be the most relevant factor that contributes to the achievement of vantages through the use of I.S/I.T.

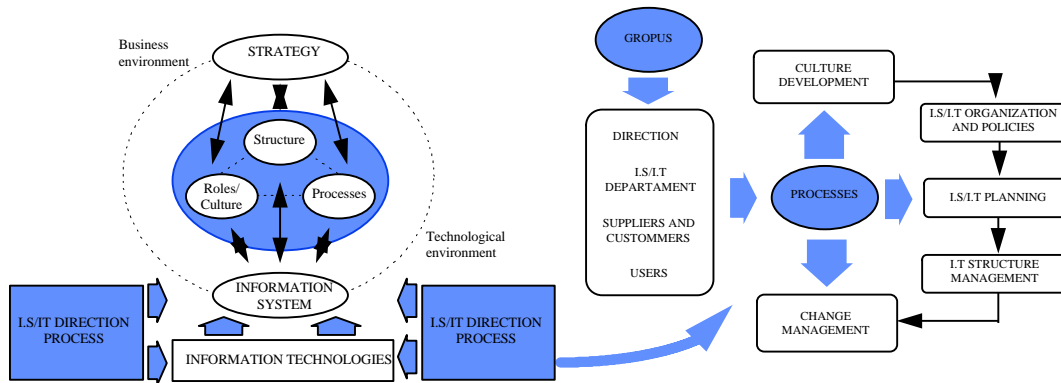


Figure 7: The I.S/I.T direction process as the third dimension of the interaction model. (Source: Authors).

THE EMPIRICAL CONTRAST

Over the second semester of 1996, we have conducted an investigation over 50 medium size companies. The investigation was oriented to characterise and contrast the interactions proposed in the model for this kind of organizations. The investigation was carried out as follows:

- We based our investigation on a survey that included questions adapted to the kind of organizations under analysis. The questions were derived from the three proposed dimensions of the interaction model. As a result we designed 235 questions (most of them closed questions to allow statistical processing).
- The survey was tested on 5 companies, i.e. a 10% of the total sample. This test phase was of critical importance, since it allowed to identify aspects that were modified, mainly with regard to the understanding of the questions stated.
- The study was sponsored by the Galician Government through its local development office (IGAPE). Confidentiality was assured to all participant companies. Surveys were anonymous, although we allow the use of personal (secret) codes, so that companies could use these codes to ask for a benchmarking report. We planned this as a fidelization strategy, as well as a tool for evaluation of the different organizations. The benchmarking tool was also part of our research work.
- We visited most of the companies to present them the objectives of the study and to explain the questions included in the questionnaire. The survey was fulfilled by the general manager in 95% of the companies. Only 5% were completed by other position, normally the organization director or the management control director.

- We have performed several statistical analysis on the data collected; descriptive analysis, factorial analysis, correlation analysis and cluster analysis. In this article we have selected some of the results obtained, making reference to each of the dimensions of the Scott-Morton modified model. The complete study and the presentation of the results are included in a PhD work referenced in the bibliography section (See Orero and Suárez, 1997).

The sample

We have focused our study in the sectors considered “strategic” by our sponsor; distribution, Fishing, Wood, Textile and Automobile.

All the companies investigated were located in Galicia, the North West Region of Spain. The distribution of companies studied was the following:

- Total sales per year (million of pts):

1-100	100-500	500-1000	1000 or more
(0%)	(18%)	(25%)	(57%)

Note that 82% exceed 500 million pts (aprox 4.000.000\$)

- Total assets (million pts):

1-100	100-500	500-1000	1000 or more
(5%)	(24%)	(22%)	(49%)

- Number of employees:

1-10	10-50	50-100	100-500	500 or more
(0%)	(30%)	(37%)	(33%)	(0%)

Note that 70% exceeds 50 employees, with 33% having more than 100.

- Number of different operative locations:

None	1-5	6-15	15-300	30 or more
(29%)	(57%)	(6%)	(2%)	(6%)

The number of operative locations (factories, offices, branches, etc) has resulted as an important factor from the I.S/I.T application point of view.

Factorial and Cluster analysis

We have performed factorial analysis, and we have identified the existence of two “strategic factors”, one “organizational factor” and one “I.S Direction factor”. The strategic factors make reference to the vantages that the organization obtains through the use of I.T and Information itself. We have performed cluster analysis grouping the companies around these strategic factors. We obtained two groups, clearly defined as showed in figure 8. After studying the characteristics of each group we named group 1 as “Operative use of I.S/I.T” and group 2 as managerial use of I.S/I.T.

We named the Group 2 as “Managerial” instead of “Strategic”, since the results of other variables showed that the only strategic use of I.S/I.T in these companies had to do with the improve of decision making.

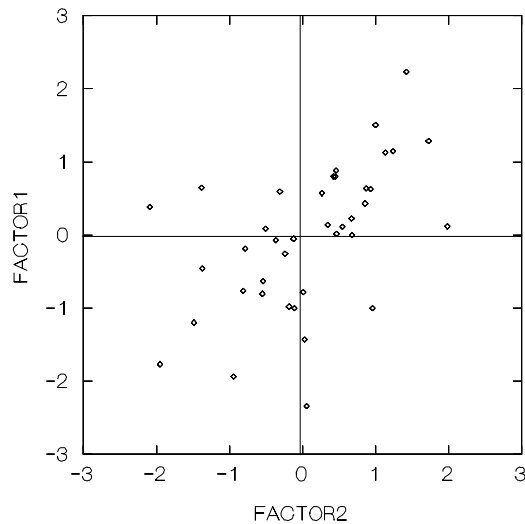


Figure 8: Results of the cluster analysis.

Other important conclusion in addition to the existence of the factors or dimensions of the model is the existing correlation between each of the dimensions. We have performed correlation analysis, to identify the possible change strategies (through cause-effect analysis). The results obtained suggest that change strategies should focus on cultural aspects first, and require the participation of the direction in what we called the I.S direction process.

With regard to the organizational dimension we have analysed many different aspects. As an example we include the results of the functional introduction of I.T. The results obtained contrast our hypotheses that stated the need to perform the analysis separating each organizational unit.

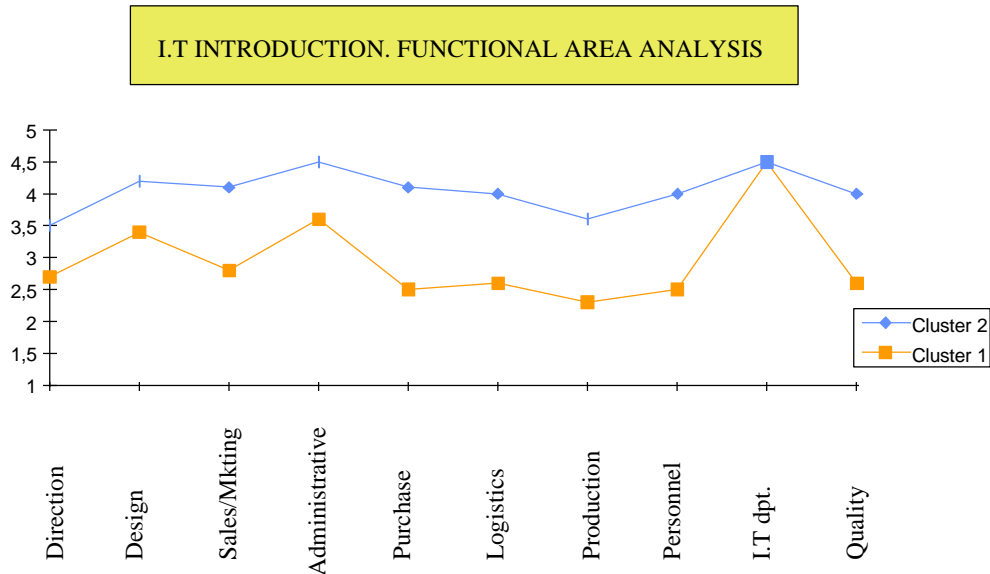


Figure 9: Comparison of the introduction of I.T per functional area for the two clusters.

CONCLUSIONS

There are several conclusions that we can emphasise in this work. On one hand, the need to continue both the theoretical and empirical study of the interactions between the Information System and the different dimensions of the organizations.

It is important to make reference to the modifications proposed to the Scott-Morton model (Orero, 96), that indicate the way to introduce the I.T in the organization. This way has a fundamental “stop” in the Information System, that must be conceived as a basic part of the complete organization. In this sense we have presented in this paper a study of the Information System concept and functioning, that can help to achieve this integration. The work has also presented some conclusions of an empirical study developed from the Scott Morton modified model. The study has helped to clarify the dimensions and the relations between them.

The strategic dimension has been analysed through the OFF model (Earl, 1996) and SAM (Henderson and Venkatraman, 1994). The comparison of the models helps to understand better the integration of I.T in the organization.

Finally, we have revised several approaches to introduce a dynamic dimension into the interaction models, revising the Silver model (1994) and the contribution of Orero and Suárez (1997) to add a third dimension to the Scott-Morton modified model.

Some of the results of our empirical investigations have also been presented. The results obtained contrast the main aspects described at a theoretical/conceptual level.

The conclusions obtained show that the I.S/I.T have both an strategic and structural impact, playing a critical role for the present and future success of organization.

REFERENCES

- Andreu, R; Ricart, J.E; Valor, J. (1994):** "Estrategia y Sistemas de Información". McGraw-Hill.
- Checkland, P. (1981):** "Systems Thinking. Systems Practice". John Wiley and Sons. New York.
- Drucker, P. (1993):** "La sociedad Postcapitalista". Ed. Apóstrofe.
- Earl, M. (1988):** "Information management: the strategic dimension" Oxford clarendon press.
- Earl, M. (1996):** "Integrating I.S and the Organization: A Framework of Organizational Fit" en "Information Management: the organizational dimension", dirigido por Earl, M. Ed Oxford University Press. Pag 485-502.
- Henderson, J., Venkatraman, N. (1994)** "Strategic Alignment: A model for organizational transformation via Information Technology". En "Information Technology and the Corporation of the 1990's" dirigido por Allen, T. y Scott-Morton M. Ed. Oxford University Press.
- Leavitt, H. (1964):** "Applied organization change in industry: structural, technical and human approaches". New York. J. Wiley.
- Nolan, R (1981):** "Como comprender y controlar la evolución del proceso de datos" Harvard Deusto Business Review. First term.
- Orero, A. (1995):** "Las Tecnologías de la Información en la empresa". En "Dirección de Empresas de los noventa: homenaje al profesor Marcial Jesús López Moreno". Dirigido por Cuervo, A. Ed. Civitas. Pág 378.
- Orero, A. (1997):** "Integración de la tecnologías de la información en la organización". Ponencia en el VII Congreso Nacional de ACEDE. Almería Septiembre.
- Sampler, J. (1996):** "Exploring the relationship between information technology and organizational structure" En "Information management". dirigido por Earl, M. Oxford University Press.
- Scott-Morton, M. (1991):** The Corporation of the 1990. Information technology and organizational transformation. Oxford University Press.
- Silver, M., Lynne, M. and Mathis, C. (1994):** "The information technology interaction model". Work Paper series. STERN IS 94-5. Stern School of Bussines. Center for Research on Information Systems. New York University. Obtained on Internet in: <http://www.nyu.edu>
- Suárez, C (1997):** "Desarrollo metodológico para el diseño de estrategias de cambio organizativo basadas en la mejora de los sistemas de información de las organizaciones". Tesis doctoral dirigida por Orero, A. Ed Publicaciones ETSIT- Universidad Politécnica de Madrid.
- Ward J. and Griffiths P. (1996):** "Strategic planning for Information Systems" 2nd edition. Willey.
- Wiseman, C. (1985):** "Strategy and Computers". Dow Jones-Irwin Homewood IL.