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IS flexibility: analysis of a flexible mobile roaming system

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□ Résumé

D'après des recherches récentes, la flexibilité joue un rôle-clé dans l'obtention d'un avantage compétitif, notamment dans un environnement changeant. Cependant, la flexibilité des S.I. n'est pas facile à évaluer. Dans un travail précédent, nous avons construit un cadre multidimensionnel des attributs de la flexibilité, qui a été soumis à des managers pour une première confrontation. Le papier décrit l'analyse du système d'itinérance (roaming) d'un opérateur de téléphonie mobile, qualifié de flexible par ses utilisateurs, à partir des dimensions de notre cadre.

Mots clefs :

Flexibilité des S.I., système d'itinérance, évaluation de la flexibilité.

□ Abstract

Recent research suggests that IS flexibility is a key factor in achieving competitive advantage, particularly in fast-changing business environments. However, IS flexibility is not easy to assess. In a previous research, we have built a comprehensive multi-dimensional framework of IS flexibility, that has been subjected to a first evaluation by managers. This paper describes the analysis of a complex roaming system which is qualified by users as flexible, based on our framework dimensions.

Key-words:

IS flexibility, roaming system, flexibility assessment.

Introduction

Recent research suggests that IS flexibility is a key factor in achieving strategic alignment, particularly in fast-changing business environments because it will allow the IS to be rapidly changed (Upton 1994; Sanchez 1995; Volberda 1998, Chung et al. 2003). The concept of flexibility has been widely used and with many different connotations (Avison et al. 1995), and several attempts have been made to define it. Concerning IS flexibility, most authors have adopted a resource-based perspective, as a way to approach the different dimensions of an IS that could be sources of flexibility (Byrd and Turner 2000; Duncan 1995). However, all the characteristics enabling flexibility are not involved in the same way depending on the context and type of the IS. In a previous research, we have built from a study of literature a comprehensive framework of IS flexibility, where an information system is viewed as a complex set of four major resources (people, IT, data and processes). Each resource is a dimension of our framework, which includes several characteristics enabling flexibility. Although the items or characteristics in the framework are related to flexibility factors, it must be considered that the ad-hoc combination of factors that result in a flexible system depends on the context observed (Evans 1991). This paper shows how the context of the environment analyzed affects the factors that are important from a flexibility point of view. It describes the characteristics of a software application; the people, data and processes that surround it that appear as relevant for flexibility purposes. It also describes the contingency factors that make those characteristics relevant.

1. Presentation of the framework

The step previous to this study was the definition of an IS flexibility framework from existent work on the subject. From a literature review, several resources that were associated with flexibility were identified. These resources came from different views of an organization because studies have shown that the whole parts of an organization should be involved for flexibility purposes (Volberda 1998). These resources were arranged in four major dimensions that form this research's view of an IS: people, process, IT and data. The people are the managers and team members involved with the design, development, and implementation of the IS as well as the IS users. Process represents a set of activities to perform a business task. IT includes the IT infrastructure and business applications in a firm. Data elements contain the information that is processed, used and manipulated by the processing components.

The next step was to evaluate this IS flexibility framework. To do that, the view of a sample of people working in the telecom industry with knowledge on the Management Information Systems field were sought and analyzed to investigate if the issues suggested by the literature and featured in the IS flexibility framework were actually perceived and utilized by practitioners as flexibility issues. The adjusted framework is shown in figure 1.

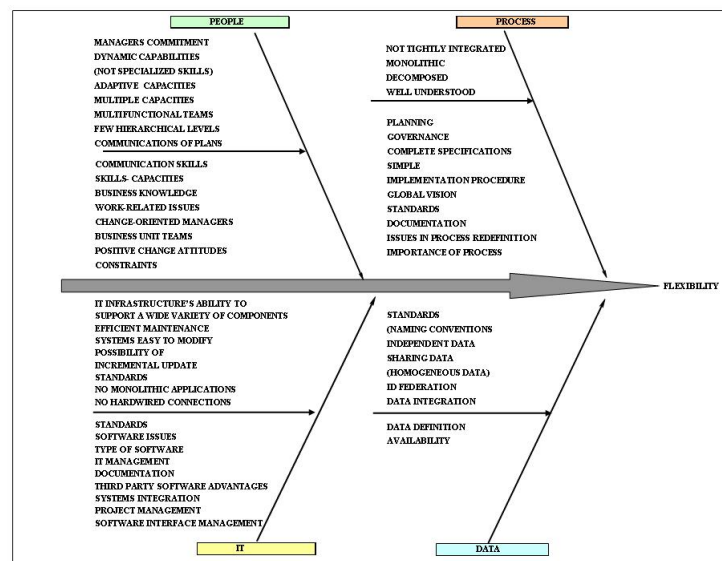


Figure 1: Flexibility framework

At the end, each dimension is composed of a set of characteristics that attempt to capture a holistic or-

ganizational view. Resource-based theory suggests that it is important to consider complex sets of or-

ganizational resources in understanding flexibility. But these resources have an effect on each other, so flexibility is the outcome of the combination of those resources and important contextual factors which also have an influence on these organization resources to result in a flexible system. The value of being flexible in one dimension may be not only due to that particular dimension but to other organizational resources such as the effect of flexibility in the remaining dimensions under particular circumstances.

2. Research question and research methodology

The problem with a multi-dimensional framework is that it lacks capturing the inter-dimension effects. The flexibility of each dimension may have an effect on the flexibility of the remaining dimensions in the same way that the strategic value of a characteristic (e.g., modularity) may be linked to the presence of other organizational resources such as flexible structures and cultures (Worren et al. 2002). Depending on a particular context, several elements from the framework yield a flexible system and some of those elements may be crucial. The basic foundation of contingency theory is that the effective of management approaches (such as implementing flexible systems) is contingent upon the organizational environment in which they are applied (Weatherbe and Whitehead, 77). Applied to flexibility, this means that there is not a single combination of elements that constitute a flexible system; these elements must fit the organizational context and contingencies.

This is why we now need to investigate the characteristics of the different dimensions of IS flexibility under a particular context to examine the leading contributors to flexibility. For this purpose it must be analyzed the variables that differentiate the organizational environment (Weatherbe and Whitehead, 77) too. Hence, a contingency approach is suitable to identify factors that may alter the characteristics of a flexible system (Lin and Shao, 00).

To have a first approach in understanding the role of the major contributors in the framework in a particular context, it was necessary to confront the framework with a complex system. The objective of this research is to study the flexibility of telecom operators IS and how to adapt them swiftly for addressing changes to face technological convergence. As part of the research, the objective of this paper is to study from a specific setting what factors must be present to make a flexible IS (considering this research's view of IS which complies four major dimensions of resources) and how the circumstances

of the specific setting affect the factors. The case study method enables the researcher to focus on understanding the dynamic present within single settings (Eisenhardt 1989) so this was the methodological strategy selected. The case study approach is a suitable theoretical construct to evaluate a framework (Leonard and McAdam, 2003).

For this case study, a mobile roaming system has been selected for three reasons. First, the system is considered as flexible application by the company where it has been implemented (new mobile services that become technologically feasible can easily be implemented in roaming mode). Second, it is a large IS application crossing functional areas and even organizational boundaries (roaming services require a complex interaction with several external entities which makes flexibility to enable this interaction an imperative). Third, it is a system where most flexibility is needed since it has to be changed quickly depending on business or markets demands (new mobile services must be offer for roaming to customers in time to market or in time to reach competitor's moves).

Data was collected surrounding the flexibility characteristics of the IS application, human and business environment (organizational characteristics, IS infrastructure characteristics, external environmental factors, etc.).

The data collection exercise was done in the form of interviews, each lasting between one and two hours. Six persons were interviewed:

- The IS Unit Director.

This unit is one of the four IT units in the company. This unit's job is to define and implement systems strategies for the company. This is done by acquiring, building or maintenance of systems through the use of an annual budget. The Director is two levels below the Chief Executive Officer.

- An IS manager

He is a technical manager responsible for the team in charge of the maintenance and operation of the IS application. He works in the IS unit and is four levels below the CEO.

- The Director of the business unit where the IS application is used.

He is two levels below the CEO

- The sub director of the same business unit, who is three levels below the CEO.
- The roaming manager and the project manager. Both are four levels below the CEO.

The qualitative data related to flexibility was extracted from the transcripts into flexibility factors to compare with the framework and see the relation among them under this scenario's characteristics. .

3. Description of the case study

The unit of analysis is a business software application in a firm. The people (managers and team members involved with the design, development, and implementation of the IS as well as the IS users), process (set of activities to perform the business task for which the application is intended and the data elements (which contain the information that is processed, used and manipulated by the processing components) are also included in the analysis.

The setting of the case study is the roaming business unit of a mobile telecommunications operator. The technology-intensive nature of an operator and the appearance of technological convergence have created a need for fast adaptation to new services, business models and strategic decisions (Campovino et al., 2003).

The Roaming System is a software platform used for rating and charging roaming services. The term roaming in the mobile industry refers to those services that allow customers from other networks and countries to use their mobiles phones when they visit any country or network outside of their home service area. Roaming is defined (cf. GSM Association Permanent Reference Document AA.39) as the ability for a cellular customer to automatically make and receive voice calls, send and receive data, or access other services when travelling outside the geographical coverage area of the home network, by means of using a visited network (another telecom operator's network).

To extend coverage for their clients in a certain geographical area, a mobile operator must sign a usage agreement with the operator owner of a network with coverage in that area. So roaming works by individual agreements between mobile phone operators. The Roaming agreements as well as the GSM mobile operators follow the standards and regulations of the GSMA¹. These agreements include the terms, conditions and pricing schema that will constitute the business relation among operators. Behind roaming services lies a complex process that gathers information about each call, about each caller and takes a standardized approach to the charges being incurred.

The Roaming system is the platform to automate the generation of charges incurred by each operator for the roaming services of their clients. Its main func-

tions include the reception of records from the networks with the usage data (number of calls, duration, etc.) for each operator; this information is used to generate a standardized file that contains the charges incurred for the roaming services. They are calculated according to the terms, conditions and tariffs established in the agreements. This file is sent to their clearing house in order to verify that the records were generated according to certain standards and the established tariffs; finally the file can be sent to the operator.

4. Analysis of the flexibility from different resources perspective

In the framework, the flexibility factors depicted belong to characteristics in a resource-based view which has already been used in the study of flexibility (Sanchez, 97).

This paper analyzes the resources characteristics from a roaming application that are related to flexibility. The characteristics of the application, people, data and processes act as a network of interconnected components with a particular degree of flexibility to enable changes in their components. This flexibility is provided by certain properties of the resources in the network in a contingency manner.

Dimensions and resources are difficult to identify; but the real problem lies in defining the correct arrangements for those resources that produce a flexible system under certain circumstances or conditions. This difficulty rises also for the nature of flexibility itself: flexibility is multidimensional with several resources in each dimension; an organization can be very flexible in some ways and less flexible in others (Golden and Powell 1998) so there is not a single arrangement of resources and because it is polymorphous (Evans 1991) so it depends on a particular context. This case serves to analyze a particular context in a company and the resources' contribution to flexibility; also to try to describe the arrangement of those resources. A used approach (Upton 1994) that this research argues as a correct way to describe resources tied to IS flexibility is the identification of multiple components of a system (for this study, the roaming system) where the contribution of each element is described and flexibility can be defined as properties of the resources. To do that, a schema of the roaming system is shown in figure 2.

¹ GSM Association (GSMA) is a global trade association representing more than 750 GSM mobile phone operators across 218 territories and countries of the world. The primary goals of the GSMA are to ensure mobile phones and wireless services work globally and are easily accessible, enhancing their value to individual customers and national economies.

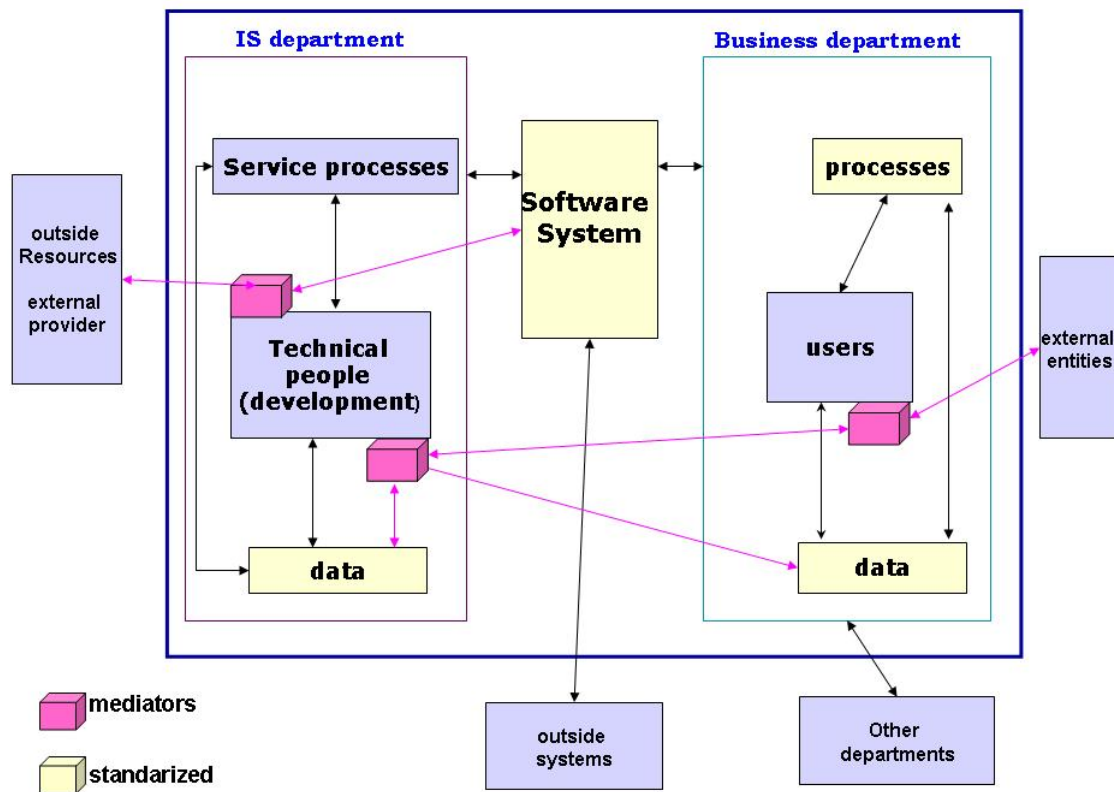


Figure 2: The roaming system arrangement of elements

This figure shows a precise arrangement of elements that act as a network to produce a certain degree of flexibility; this flexibility changes if the network configuration is altered. Another factor that yields a flexible system is the presence of certain elements with particular properties that are important mainly under a certain context. The elements or resources in figure 2 (their characteristics and circumstances) related to flexibility are described below.

IT.

For this research, IT refers to the application where the roaming operation is automated. It is a commercial product that was acquired two years ago to substitute a legacy system that could not easily support charging different roaming services. The legacy system was built in-house by a development group which is physically located in a different country from the maintenance team. Whenever modifications were needed, both teams (the development and the maintenance) had to interact. As communication protocols are not well defined and the application was difficult to modify, there were delays on requesting and receiving software modifications and a mismatch in the performance needed and delivered. The Roaming System was commercially developed to be used as a standard platform for several mobile operators in the roaming services by a provider with vast knowledge in the industry. Due

to this fact it was conceived with an architectural design that enabled customization by modularity and well defined interfaces; and followed several standards that are use world-wide in the industry (dictated by the GSMA) so it is highly standardized. Its functional architecture is designed to be modular and with clear defined interfaces to introduce new functionality.

In this company the Roaming System has a degree of independence from other systems. This is a good flexibility property because the company studied lacked general standards for integration or compatibility among systems. Well defined interfaces had been defined to connect with the two systems that are the source and destination of the roaming system. These connections are flexible because they follow GSMA standards. The system is configured and maintained by the IS Department with the request and configuration documents elaborated by the business Department. All these factors enable change; i.e. it does not take long to modify the system to include the rating and charging the roaming charges of new services (such as CAMEL or roaming of pre-paid, GPRS, UMTS and HSDPA) if the company decides, as a strategy, to use them. This was not possible with the legacy system due to difficulties in adding modules or programming the needed functionality.

IS department

The IS department can be described by 3 components: technical people involved in the maintenance and operation of the software, processes of the unit and data used.

Technical people are organized in teams assigned to a single business unit. Each team is independent for budget planning and decision taking. The roaming team is composed by an IT manager, one project leader, one programmer and three or more specialized programmers externally. The independence of the teams enables the roaming IT manager to act faster because he can allocate resources without prior authorization. On the other hand this independence makes communication among teams important because usually software platforms interact or share data. In this case, communication is a flexibility inhibitor because it is not well established or standardized.

The architectural design is built to be flexible, but it is complex. This means that the modification of the source code is not an easy task considering that its properties must not be altered so a certain degree of specialization in the internal functionality and programming of the software is needed. For that task, technical people in the roaming unit include external specialized programmers working for the software provider. In general, specialization is opposed to flexibility; in this case, as specialized resources are hired on demand they act as a source of flexibility for the following reasons: 1) they use their specialization knowledge to develop fast but once they finish the job those resources are released; 2) The manager does not have to formulate an accurate request-for-change document to explain the modification needed because he can directly communicate and supervise the programmer; misunderstandings in specifications are reduced too; 3) it is not necessary to follow the procedure established for purchasing a module modification to the software provider which is long, bureaucratic and time consuming in this company. On the other hand, hired resources are expensive; the team must manage an annual budget which can be not enough if too many unplanned modifications are needed or if resources are not well managed. Projects can be delayed due to lack of resources. This fits with previous findings where flexibility is acknowledge having a cost (Nelson and Ghods, 1998).

IS department must have good communication with the users (people from the business department in this case) to understand what the requirements are so they can translate them into software solutions. If needs are not clearly understood, the system is incorrectly modified even though good interfaces and modularity make the job easier. With this in mind, technical and business skills are promoted in the

teams although there are no written policies. This agrees with the fact that multi skills in people promote flexibility. In this particular case, although people are technical-oriented, to be flexible they must also have business skills as it enables them to develop faster through understanding. The main communication task relays on the manager because he has a high degree of interaction with internal users and the outside provider. His actions are towards mediation between parties and thus he acts as a mediation entity. His role in this network is fundamental. He mediates at two levels: with his counter part in the business department (a person designated by the business department to mediate with internal and external business entities) in issues concern with the understanding of requirements; and also with the outside provider for hiring resources. An important fact for flexibility purposes is that there is a shared knowledge between business and IS mediators; the business manager understands up to a certain level about the software architecture and the IS manager understands well the dynamic of the roaming operation. Some of the manager's properties that are flexibility related are: he has well develop skills of both, commercial understanding of the environment and technical knowledge of the platform which enables him to plan, decide and implement changes faster. He has good communication skills and is oriented towards change.

Processes of the IS department. All new changes or maintenance requested by the user must follow certain processes defined at corporate level. These processes are perceived by the IS department as bureaucratic. Although it is recognized that some procedures must be followed, the long approval processes restrain their flexibility.

Data of the IS department. Some of the data the Roaming System needs to operate comes from a legacy system difficult to query and very inflexible due to lack of well defined interfaces. The roaming team decided to maintain a copy of that data. This solution was decided to have flexibility by having the data available when needed. Although this solution is prone to integrity problems, it enables them to act swifter. Relating to data standards, there are no in-house standards defined for data. Outside resource are permitted to follow their own data standards as they use the ones established by the GSMA. These standards are used in the industry so programmers know them well.

Business department.

For this research, this term refers to the enterprise's organizational unit that uses the roaming system for their operation; it includes the human resources, processes and data needed to operate. In this research the business department is the Roaming

Unit. It belongs to the Carriers Division which is the part of the company whose main function is the relationship and business operations with other carriers to provide services. The roaming business people are mainly concerned with the negotiation, definition and signing of very precise agreements needed to establish the business relations. These tasks involve a high degree of interaction with internal and external entities.

Users. The human resources in this department are oriented towards negotiation and interaction. The roaming manager of the unit plays an important role in the contribution to flexibility; she has a mediation role in the network. Her job is oriented to negotiate with several entities, mainly other carriers. They constitute the main source of changes for the roaming system as new agreements or modifications must be implemented. The roaming manager negotiates the terms and conditions of the agreements with them and with other departments (such as legal or networks). She must also mediate with the technical people from the IS department because for each agreement signed, she delivers them the specification of the parameters to configure the software system. This task demands specific skills such as a high experience and a deep knowledge of the business and communication skills. It is also required to know well the standards of the GSMA as they play a part in all the operation.

Processes of the Business department. Internal processes are documented and standardized (ISO9001 and GSMA) inside the business unit. This standardization enables flexibility because rules and procedures are well defined and interaction for communication purposes is reduced. When there are changes and communication is mandatory, it introduces time, misunderstandings and delays. Interaction with other carriers is electronic which makes it less prone to mistakes and eliminates the need to communicate once the contract is signed.

Data of the Business department. The data exchanged with outside and internal entities is highly standardized too. It does not change often because it is defined in a contract which makes it less prone to be changed. Standardization at this level is vital (to operate, charge and bill) so people is obliged to know it well; this means that if changes are needed they can be introduced faster with this knowledge.

From the description of this arrangement of elements it is possible to identify for each resource or dimension the flexibility factors from the framework. Table 1 shows the elements, characteristics and contingency factors extracted from the roaming case study.

Dimension of the resource	Characteristic	Contextual factors that make the characteristic relevant for IS flexibility	Referenced to this item in the framework
IT	commercially developed	dynamic business environment	ability to support a wide variety of components
IT	architectural design to be flexible	standardized environment world-wide	ability to support a wide variety of components
IT	modularity	dynamic business environment	ability to support a wide variety of components
IT	well defined interfaces	dynamic business environment interaction with several other systems	ability to support a wide variety of components standards
IT	regulating figure	standardized environment world-wide	standards
IT	independence	studied lacked general standards for integration or compatibility among systems	no monolithic application/ no hardware connections
people (technical)	technical external resources available	high degree of specialization needed	efficient maintenance
people (technical)	faster allocation of resources	independence of the teams	multifunctional teams

Dimension of the resource	Characteristic	Contextual factors that make the characteristic relevant for IS flexibility	Referenced to this item in the framework
people (technical)	good communication among teams	independence of the teams	communication skills
people (technical)	good communication with business department	software alteration/addition is formulated by the business department	communication skills
people (technical)	specialization in programming	specialized resources hired on demand	adaptive capacities
people (technical)	good management of budget	specialized resources hired on demand	business knowledge multiple capacities
people (technical)	technical and business skills in members of teams	software alteration/addition is done by the IS department	business knowledge multiple capacities
people (technical)	manager as a mediation entity	high interaction between IS and business department high interaction with external provider	business and technology knowledge multiple capacities communication skills adaptive capacities
people (business)	skills oriented for negotiation and interaction	high interaction with IS and other departments (such as legal or networks) and with external entities (other carriers)	communication skills
people (business)	manager as a mediation entity	high interaction with IS and other departments (such as legal or networks) and with external entities (other carriers)	business and technology knowledge multiple capacities communication skills adaptive capacities
process	standardized	high degree of interaction with external entities for data exchange	process standards
process	short approval process for performing a requested alteration/addition	dynamic business environment	simple procedure
process	automated	high degree of interaction with external entities	complete simple
data	data available when needed	source of data needed is an inflexible system	data independence
data	standardized	high degree of interaction with external entities for data exchange	data standards

Table 1: Flexibility and contingency factors

5. Confronting the framework with the case study: lessons from the case

In this case, three elements have a main and precise role in achieving flexibility. Following is their description.

1. The existence of standards which facilitate flexibility because they define how data and business processes must be; so once business and IS people know them well they know how to act. This high standardization also means that they are less likely to change. Standards in this particular case have a high impact because they are highly enforced by an external entity; they are defined at all levels which brings a balance. They set the rules for the engagement between business department and the external entities (other mobile operators) which is crucial in this scenario.
2. The architecture in the software system. It was designed to be flexible and customizable. It is modular with interfaces and parameters easy to configure. This enables the implementation of new roaming agreements agile. This fit findings of past literature. Byrd and Turner (2001) describe a flexible IT infrastructure as one being able to support the design, development, and implementation of heterogeneity of business applications. The software application easily follows industry standards and can include the use of new technologies by adding new standardized modules. This enables the IS department to respond quickly and cost-effectively to systems demands, which evolve with changes in business practices or strategies Duncan (1995).
3. Mediators: key people who play the role of mediators. One belongs to the IS department and the other to the business department. They interact with each other to exchange the data to configure the software system in the case of a new agreement implementation and all the information and formal description of new modifications needed in the system due to new needs coming from the business department. Both of these mediators share certain business and technology knowledge which enables the flexible interaction among them. They also act as a frontier objects who mediate with the outside. This task is relevant in both cases: for the business department because the operation is based on relations and agreements with other operators; for the IS department because their maintenance team is based on external human resources. Both mediators have skills related to flexibility: communication, knowledge and adaptability. This finding is congruent with that of (Byrd and Turner 2001) where their study shows that the IT personnel flexibility factor contributes the most among the

contributes the most among the factors of the flexible IT infrastructure.

Conclusion

This work is part of an ongoing investigation in IS flexibility. Initial research produced an IS flexibility framework which identified some attributed to assess flexibility in 4 dimensions: people, process, data and IT. This paper presents the configuration of those dimensions and a case study as an example of achieved flexibility. It describes for this case study, the elements that are enablers for flexibility and the relation among them under a particular setting. From the study it becomes clear that relation among elements is important; not only the single flexibility characteristics displayed by each element. The case shows that the problem of how to be flexible at the IS level is concerned with defining the adequate characteristics of each element in the systems and also in the interaction among them. It was also necessary to consider the effect of contingency factors on flexibility due to the polymorphous nature of flexibility itself.

In this case study the main contingency factor is the high degree of standards establish at different levels: data, process and IT. Within this context the leading factors are: the software characteristics that make it very customizable, achieved through an easy addition of new modules and good interfaces and key people who act as mediators; they have some precise competences (business and technical knowledge, multiple capacities and communication skills).

The next step in the research is to study flexibility in a different context. A billing system in the same company will constitute the next case because it has important differences with the present case: it is not submitted to standards and regulations. The results are expected to be different even though the same model will be used.

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