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**Thèse de doctorat de l'INSTITUT NATIONAL DES TELECOMMUNICATIONS
dans le cadre de l'école doctorale SITEVRY en co-accréditation avec
l'UNIVERSITE D'EVRY-VAL D'ESSONNE**

Spécialité: Ingénierie des Connaissances et des Systèmes d'Information

Par

Mme Laura JACOME MADARIAGA

**Thèse présentée pour l'obtention du grade de Docteur
de l'INSTITUT NATIONAL DES TELECOMMUNICATIONS**

**Design and Evaluation of an IS Flexibility Enabler Framework: a
Contingency Theory Approach**

Soutenue le 15 Décembre 2009 devant le jury composé de :

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Manuel MORA, Professeur à l'Université Autonome du Aguascalientes, Mexique, Rapporteur

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Thèse n°2009TELE0024

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Nothing great in the world has ever been accomplished
without passion.

Hegel



FORMATION DOCTORALE

Dans le cadre de l'Ecole Doctorale SITEVRY

l'Institut National des Télécommunications en co-accréditation avec l'Université d'Evry-Val d'Essonne

Résumé

Thèse de Doctorat : Conception et évaluation d'un cadre conceptuel pour
l'étude de la flexibilité des systèmes d'information: une approche
contingente

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Confrontées à des changements de plus en plus fréquents et imprévisibles, les entreprises prennent des risques si elles continuent d'utiliser les approches traditionnelles de management (Volberda, 1997). Dans le monde industriel, la globalisation, les avancées technologiques, les demandes de personnalisation souhaitées par les clients, ainsi que le raccourcissement du cycle de vie des produits et services, génèrent des besoins de changement difficiles à anticiper. Dans un tel environnement, parfois qualifié de « turbulent » (Volberda, 1997) car les changements y sont fréquents et radicaux, les entreprises doivent faire preuve de réactivité face aux

défis et aux opportunités. Le secteur informatique, l'industrie des semi-conducteurs ou celle des télécommunications en sont de bons exemples.

La turbulence de l'environnement remet en question la notion de stratégie, car l'incertitude extrême des évolutions possibles sape le principe de la planification stratégique (Ansoff, 1978). Dans un tel contexte, les entreprises sont appelées à redéfinir en permanence leur stratégie, ce qui n'est pas sans conséquence pour les systèmes d'information. En effet, leur alignement sur la stratégie et sur la structure organisationnelle peut avoir une influence déterminante sur la performance de l'entreprise. Si cette adéquation n'est pas trouvée, les technologies d'information (TI) utilisées n'apporteront pas les avantages escomptés (Henderson et Venkatraman, 1993). Plusieurs études ont ainsi montré que les organisations où les TI sont alignées sur la stratégie seraient moins sensibles aux changements externes, et par conséquent plus performantes (Bergeron et al. Broadbent et Weill, 1999). L'alignement stratégique est un point particulièrement important pour les entreprises mobilisant des ressources importantes pour concevoir, mettre en œuvre et faire vivre leur système d'information (SI), dont elles attendent une valeur en retour. Dans un environnement turbulent, la principale question qui se pose aux entreprises lors de leurs évolutions stratégiques est alors : comment adapter et modifier leurs systèmes d'information ?

La notion de flexibilité, appliquée aux SI, apporte une réponse. De façon générale, la flexibilité est la capacité de l'entreprise à s'adapter aux changements rapides et aléatoires de l'environnement, (Aaker and Mascarenhas, 1984). Elle mesure la réactivité de l'entreprise face aux pressions concurrentielles et sa faculté d'adaptation à tous les types de changements (Prastacos et al. 2002). C'est donc une qualité que l'on peut rechercher pour les systèmes d'information soumis à des demandes fréquentes d'évolution. Cependant, il n'existe pas de théorie ou cadre conceptuel, expliquant précisément comment on pourrait développer un SI flexible, pouvant s'adapter aux changements. Par ailleurs, on peut observer une faible prise en compte, dans les recherches sur la flexibilité des SI, du fait que la flexibilité est un concept polymorphe, comme cela a été développé dans d'autres domaines (Evans, 1995). Cela signifie qu'elle peut prendre des formes différentes selon les contextes.

L'objectif central de cette recherche est d'étudier les caractéristiques de la flexibilité des SI, dans la perspective d'apporter une aide à la construction de SI plus flexibles, pouvant s'adapter rapidement aux changements, notamment en cas d'évolution stratégique. La question posée est donc : comment atteindre la flexibilité dans les SI ? Cette recherche s'appuie sur les recherches antérieures décrivant les caractéristiques de la flexibilité d'un SI et les enrichit en prenant en compte les différentes dimensions d'un système d'information. Elle inclut ensuite dans son analyse les caractéristiques contextuelles du système d'information dont on recherche la flexibilité, avec l'idée sous-jacente d'une flexibilité polymorphe, c'est-à-dire pouvant prendre des formes différentes selon le contexte. Le but est donc d'identifier ce que représente la flexibilité d'un SI et quels sont les moyens pour l'atteindre.

Revue de la littérature : de la flexibilité dans la fabrication à la flexibilité dans les SI

La flexibilité est un terme utilisé dans diverses disciplines de gestion, qui fait référence à une qualité nécessaire dans toute organisation. Les différents usages du mot ont en commun de vouloir apporter une réponse à des problèmes de rigidité des processus à différents niveaux de l'entreprise.

La fabrication est le premier domaine où l'on a défini la flexibilité. Deux visions différentes ont été utilisées: un point de vue selon lequel la flexibilité est déterminée par la présence obligatoire de certains éléments, et un point de vue plus stratégique où les éléments déterminants de la flexibilité sont liés à la stratégie de l'entreprise. Dans cette dernière perspective, les SI sont considérés comme une source de flexibilité pour l'entreprise, et la plupart des chercheurs se sont focalisés sur les différents composants des SI dont les caractéristiques influent sur la flexibilité organisationnelle.

Flexibilité de la production : réduction des sources d'inflexibilité

Dans l'approche « déterminante » de la flexibilité en production, la principale préoccupation est de trouver les déterminants de la flexibilité. Les travaux d'Upton (1994, 1995, 1996) montrent qu'il existe différentes sources de flexibilité, à différents niveaux. L'approche stratégique, quant à elle, montre que la flexibilité est étroitement liée à la stratégie : pour chaque catégorie de stratégie, il existe un type de flexibilité associé.

Conceptualisation de la flexibilité

Certains auteurs ont travaillé sur une définition de la flexibilité, qui puisse être utilisée à un niveau organisationnel. Evans (1991) a développé une définition conceptuelle, en faisant l'inventaire des termes similaires. Il met en évidence l'utilisation de nombreux mots qui semblent synonymes (élasticité, agilité, robustesse, versatilité, etc.) pour faire référence à une capacité d'adaptation. Devant cette prolifération, il se demande pourquoi il existe tant de termes apparentés et formule l'hypothèse suivante : la flexibilité est un concept polymorphe. Cela signifie que les différents termes représentent des formes de flexibilité différentes, et que la forme effective que prend la flexibilité dépend d'une situation spécifique ou de facteurs relatifs au contexte. Aucun de ces termes n'est une représentation unique de la flexibilité. Ainsi, les attributs qui définissent une certaine forme de flexibilité dans une situation donnée ne sont pas les mêmes dans d'autres situations.

La flexibilité du point de vue des ressources

Dans ses recherches, Sanchez (1995, 1997) met en évidence que la flexibilité dépend des ressources. Plus précisément, certaines ressources possèdent des caractéristiques de flexibilité (ressources flexibles). C'est notamment le cas si elles peuvent avoir différentes utilisations ou peuvent être rapidement modifiées pour d'autres usages. Une utilisation adéquate des ressources flexibles favorise la flexibilité de l'organisation.

SI et flexibilité de l'entreprise

Définition de flexibilité

Dans la littérature sur les SI, le terme de flexibilité est défini de manière ambiguë (Golden et Powell, 2000), et il n'existe pas de définition universelle. Nelson et Ghods (1998), Byrd et Turner (2000, 2001) et Duncan (1995) ont apporté des contributions importantes, incluant des perspectives liées aux ressources (RBV, Resource based view). Les définitions font référence aux composants ou aux ressources impliquées. Byrd et Turner (2000, 2001) définissent la flexibilité de l'infrastructure d'un SI comme la capacité de gérer aisément une grande variété de matériels, de données, d'applications, de savoir-faire et de compétences, liés aux TI implémentés dans l'entreprise. Il faut cependant relever que, dans la littérature, nombre d'auteurs parlant de flexibilité du système d'information font le plus souvent référence au seul aspect technologique.

Les composants de la flexibilité

Certains auteurs étudient les composants de la flexibilité. Par exemple, Duncan (1995) mentionne que pour avoir une infrastructure flexible, les éléments constitutifs de l'infrastructure devraient pouvoir être partagés et réutilisés. Byrd et Turner (2000, 2001) ont un autre point de vue. La flexibilité de l'infrastructure du SI est exprimée à travers trois facteurs : l'intégration, la modularité et la flexibilité du personnel.

Une analyse des travaux antérieurs sur la flexibilité des SI montre que les définitions focalisent sur les facteurs liés à la flexibilité, que l'on peut appeler « facilitateurs de flexibilité. Mais on observe qu'il n'est pas fait mention de diverses formes de flexibilité.

Conclusion sur la revue de la littérature : vers une approche contingente

De la revue de littérature, nous pouvons conclure:

1. Le besoin de flexibilité naît des incertitudes internes et externes.
2. La flexibilité peut être étudiée à partir de ses facilitateurs ou des ressources qui donnent une capacité de changement.

3. Le caractère polymorphe de la flexibilité, bien que mis en évidence dans d'autres domaines, n'est pas pris en compte dans l'étude des SI.

Ce dernier point conduit à explorer, dans notre recherche, la pertinence d'une approche contingente pour étudier la flexibilité des SI. D'après la théorie de contingence, certaines caractéristiques, notamment liées à l'environnement, modifient la nature des facteurs qui influent sur la performance. Par exemple, pour Zhang (2006), les ressources produisent de la flexibilité organisationnelle seulement sous certaines conditions, comme les conditions externes. Si la théorie de la contingence s'applique effectivement au domaine des SI, ce qui signifie que la flexibilité des SI prendra des formes différentes selon les caractéristiques liées à l'environnement. Plus précisément, les facilitateurs de flexibilité, éléments qui expliquent d'où provient la flexibilité, pourront varier selon le contexte.

Structure de la recherche - Méthodologie

Le terrain retenu pour la recherche est celui d'un opérateur de télécommunication, soumis aux turbulences de l'environnement. L'analyse a porté sur des systèmes d'information considérés par l'entreprise comme flexibles, et liés aux aléas des évolutions stratégiques (alliances, intégration de nouvelles technologies...).

Les étapes de la recherche furent les suivantes :

1. Produire une définition de la flexibilité d'un système d'information.
2. Définir un cadre conceptuel des facilitateurs de la flexibilité d'un SI, prenant en compte les recherches antérieures.
3. Mener une étude exploratoire afin de recueillir le point de vue de managers participant à l'élaboration de la stratégie et aux décisions de changement dans l'entreprise, sur la flexibilité des SI.
4. Réaliser une étude dont l'objectif est de comparer des systèmes d'informations ayant différentes caractéristiques et analyser leurs facilitateurs de flexibilité. Deux études de

cas ont été sélectionnées pour tester notre hypothèse qui montre que tous les facilitateurs présents ou identifiés dans le cadre conceptuel ne sont pas nécessairement pertinents pour tous les systèmes d'information.

Cadre conceptuel pour l'étude de la flexibilité d'un système d'information

Dans cette recherche, la flexibilité d'un système d'information est définie comme la capacité des ressources humaines et technologiques (qui collectent, stockent et restituent l'information) à s'adapter aux changements, de façon à ce que les activités de l'entreprise puissent être réalisées de façon continue.

Le cadre conceptuel d'étude de la flexibilité des SI a été défini selon une perspective basée les ressources (RBV), prenant en compte quatre dimensions : les processus, les compétences des acteurs, les données et les technologies de l'information. Nous avons utilisé le modèle de Henderson et Venkatraman (1992,1999) pour inclure les éléments permettant un alignement du SI sur la stratégie. Chaque item du cadre conceptuel correspond à un facilitateur de flexibilité pour un système d'information.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business process	Technology
Well documented	Well defined software process	multiskills	Knowledge of the business	Functional Modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical modularity		Location free access
Process decoupling							Data Scalability

Cadre conceptuel la flexibilité des SI

Dimension processus

D'après Alter (1996, 1999), un processus se compose de différentes étapes, se déroulant dans le temps et dans l'espace, et il comprend des entrées et des sorties. Dans une perspective SI, il existe deux catégories de processus : les processus métiers et les processus liés à la mise en œuvre des technologies d'information.

Les processus métiers organisent le déroulement des activités clés de l'entreprise (Henderson et Venkatraman, 1992, 1999). Les deux facilitateurs de flexibilité suivants ont été extraits de la littérature: une bonne documentation (description complète et précise des tâches du processus, ainsi que leur séquence et les flux de données) ; et le découplage des processus.

Les processus TI sont liés à l'infrastructure opérationnelle et comprennent les processus de développement et de maintenance des systèmes techniques. Un processus bien défini, c'est-à-dire formalisé clairement et de façon détaillée, représente un facilitateur de flexibilité.

Dimension compétences des acteurs

Cette dimension fait référence aux acteurs qui interviennent dans les processus métiers ou TI, et plus particulièrement à certaines de leurs compétences qui jouent un rôle clé pour la flexibilité.

En ce qui concerne les acteurs métiers, deux facilitateurs ont été mentionnés dans la littérature : la possession de compétences multiples ; et la possibilité de s'appuyer, en cas de besoin, sur des personnes ayant des connaissances techniques. En ce qui concerne les compétences des acteurs TI, le point central pour la flexibilité est la capacité à manager efficacement l'infrastructure TI (Henderson and Venkatraman, 1992,1999). Deux facilitateurs ont été identifiés par les recherches antérieures : la connaissance du métier (processus et objets métiers) ; et une compréhension générale du fonctionnement de l'entreprise, notamment l'articulation entre les entités concernées par l'infrastructure que ces acteurs gèrent.

Dimension technologies de l'information

Cette dimension fait référence aux logiciels et matériels mobilisés dans le SI (Alter, 1996, 1999). D'après Henderson et Venkatraman (1992, 1999), on peut déduire que les facilitateurs se divisent en deux catégories. D'une part, ceux qui concernent les applications : les fonctionnalités sont réparties dans des modules qui peuvent être facilement modifiés et sans conséquence sur le reste de l'application ; et le logiciel est

paramétrable. D'autre part, deux facilitateurs concernent la configuration technologique : des interfaces standardisées avec des règles précises de communication entre les modules ; et la modularité des composants techniques qui permet d'ajouter, de modifier et de supprimer facilement, et de façon contrôlée, n'importe quel élément, sans conséquence sur d'autres éléments.

Dimensions données

Cette dimension fait référence aux informations utilisées dans les processus, qui sont saisies, transmises, stockées et restituées grâce aux TI (Alter, 1996, 1999). Le facilitateur de flexibilité pour les informations métiers est la standardisation. Pour les données techniques, nous avons relevé trois facilitateurs dans la littérature : l'indépendance des données par rapport aux applications ; l'accès transparent à partir de n'importe quel lieu ; et l'extensibilité des données, c'est-à-dire la capacité à ajouter de nouveaux types de données.

Étude exploratoire

Dans notre étude exploratoire auprès de managers de l'entreprise de télécommunication sélectionnée comme terrain, nous avons mené dix entretiens semi-directifs, avec des questions ouvertes sur les facilitateurs de flexibilité.

En ce qui concerne les compétences des acteurs, l'accent a été mis par les interviewés sur une exigence d'interaction et de collaboration entre les acteurs des entreprises de télécommunications, pour faire face aux changements dans l'environnement turbulent.

En ce qui concerne les processus, les managers situent les problèmes de flexibilité dans les étapes antérieures à leur implémentation. Ils ont ainsi mentionné la nécessité d'une définition complète et correcte du processus pour une meilleure implémentation.

En ce qui concerne les technologies de l'information, les commentaires suggèrent que les problèmes de flexibilité des systèmes d'information sont principalement liés au management de la technologie.

En ce qui concerne les données, les entretiens montrent que l'établissement de conventions terminologiques accroît la réactivité des acteurs, car ils partagent le même vocabulaire.

Étude de cas

Pour répondre à la question « Comment détermine-t-on les facilitateurs pertinents pour un SI ? », nous avons mené deux études de cas de SI flexibles et étroitement liés à la stratégie. Dans les deux cas, la flexibilité est un facteur essentiel pour l'entreprise, car ces systèmes jouent un rôle majeur dans la mise en œuvre de changements d'origine stratégique. L'objectif était de comparer des SI qui possèdent des caractéristiques différentes, afin de déterminer quelle était la forme prise par la flexibilité dans chacun des cas. L'hypothèse était que tous les facilitateurs identifiés dans le cadre conceptuel ne sont pas nécessaires dans tous les cas.

Les deux systèmes d'information sont décrits selon les dimensions qui constituent un SI : processus, acteurs, données et technologies de l'information utilisées. Dans les deux cas, les informations ont été recueillies à travers des entretiens, par l'observation et via des sources d'informations dites secondaires. Pour chacun, six personnes ont été interviewées.

Description de l'étude de cas concernant le Roaming

Le Roaming (itinérance) est le service proposé par les opérateurs de téléphonie mobile pour permettre l'accès à leurs services à partir d'un autre réseau national ou dans un autre pays, grâce à des partenariats entre opérateurs. Le coût facturé pour l'utilisation d'un réseau extérieur est calculé à partir d'informations échangées entre les deux opérateurs concernés. Les services de roaming impliquent donc de nombreuses interactions entre opérateurs.

Les opérations de roaming sont standardisées par le GSMA (une entité indépendante), ce qui conduit à une simplification dans les interactions, puisque les règles et les spécifications des échanges sont imposées. Dans cette étude de cas nous présentons les divers éléments qui composent le roaming. L'application Roaming correspond à la plateforme qui automatise le calcul des coûts encourus par chaque opérateur pour chacun de ses clients. Dans le Département Systèmes d'information, le personnel est organisé en équipes, chaque équipe étant en charge d'une unité. Celle affectée au Roaming est responsable de l'application. Les personnes qui travaillent dans l'unité de Roaming utilisent l'application, et se chargent principalement des négociations, de la définition et de la signature des accords nécessaires à l'établissement des relations.

Description de l'étude de cas concernant le Data Warehouse

Dans le système d'information de Data Warehouse (DWH), l'unité de business intelligence occupe une place centrale. Cette unité doit fournir des rapports à partir des informations opérationnelles de l'entreprise, pour la prise de décision, la définition des stratégies et le suivi de la performance des services. Le DWH est une application orientée vers le stockage des informations générées par les opérations quotidiennes de l'entreprise (nombre d'appels, minutes utilisées, informations sur les clients, etc.). Au moment de leur création, ces données sont stockées dans diverses bases de données, appartenant à différentes unités. Elles sont ensuite sélectionnées et téléchargées pour alimenter le DWH. Ce dernier permet un stockage centralisé, facilitant la création de rapports et l'analyse des informations. Le personnel technique est responsable de la modification des paramètres de configuration. Ce personnel réalise aussi d'autres activités, notamment la production de rapports complexes. C'est l'éditeur du DWH qui modifie le code associé au DWH.

Résultats

Étude de cas 1 : Système de Roaming

1. Processus. Dans cette étude de cas, nous avons trouvé deux facilitateurs pertinents : la standardisation des processus ; et leur documentation. En effet, les processus doivent être parfaitement maîtrisés et cohérents entre les entreprises participantes. La standardisation garantit que les opérations entre opérateurs sont sous contrôle et qu'elles sont réalisées exactement de la même façon pour chacun des opérateurs. Lors d'un changement, la documentation est essentielle pour déterminer rapidement la partie du processus qui sera impactée.

2. Compétences. Du côté des acteurs métiers, les facilitateurs de flexibilité mis en évidence dans cette étude de cas sont les compétences multiples des acteurs, ainsi que la présence parmi eux de quelqu'un pouvant faire l'interface entre le métier et la technique. En effet, un acteur qui possède des compétences multiples pourra réagir plus rapidement face à des situations incertaines ou des changements imprévisibles, sans avoir à consulter d'autres personnes. La présence d'un interface métier-TI est très importante car les applications jouent un rôle fondamental dans cette activité : les services de roaming sont fournis à travers l'utilisation de TI complexes à l'intérieur et à l'extérieur de l'entreprise. Du côté des acteurs TI, une connaissance du métier augmente leur capacité à prendre en compte rapidement les demandes de modification.

3. TI. Les facilitateurs de flexibilité identifiés pour ce qui est de l'application, sont la modularité fonctionnelle et le paramétrage. Ces caractéristiques permettent de d'adapter les applications sans avoir à changer le code, ou uniquement des parties bien circonscrites. Pour ce qui est de la configuration technique, la standardisation des interfaces et la modularité technique facilitent la maintenance évolutive.

4. Données. La standardisation de données est un facilitateur clé de la flexibilité, car elle permet un échange facile d'information entre opérateurs, et dépourvu d'ambiguïté.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business	Technology
Well documented	Well defined software process	Multiskills	Knowledge of the business	Functional modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical Modularity		Location free Access
Process decoupling							Data Scalability

Les facilitateurs de flexibilité du cas du système de Roaming

Étude de Cas 2 : DWH

1. Processus. Le principal facilitateur est le découplage des processus. Le fait que leurs processus soient indépendants les uns des autres permet d'effectuer librement des modifications dans les activités. Ceci est important, car les rapports demandés par les managers nécessitent souvent l'établissement de requêtes complexes, toujours différentes, et les réponses doivent être fournies dans des délais très courts.

2. Compétences. Les facilitateurs pertinents en ce qui concerne les acteurs métiers sont leurs compétences multiples et la présence parmi eux d'un intermédiaire métier-technique. Étant donné que l'information provient de sources diverses, la présence d'un intermédiaire permet de développer de bonnes solutions à partir de l'extraction des données. En ce qui concerne le personnel technique, les facilitateurs de flexibilité sont les connaissances métier et des connaissances élargies sur le secteur d'activité. Ces caractéristiques leur permettent de comprendre les problèmes qui entourent la production d'information dans l'entreprise.

3. TI. En ce qui concerne la dimension TI, tous les facilitateurs du cadre conceptuel sont pertinents. Le DWH doit être suffisamment souple pour permettre le stockage de toute nouvelle information. Ceci est possible grâce aux caractéristiques de modularité de

l'application et aux possibilités de paramétrage. Étant donné que les données sont téléchargées à partir de différentes sources, la standardisation des interfaces représente également un facilitateur pertinent.

4. Données. Le DWH est un système orienté vers stockage d'informations pour la production de rapports complexes. Pour réaliser ces tâches de façon efficace (facilement et le plus vite possible), tous les facilitateurs de flexibilité doivent être présents : standardisation de données, indépendance des données par rapport à l'application, accès transparent à partir de n'importe quelle localisation, et extensibilité.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business	Technology
Well documented	Well defined software process	Multiskills	Knowledge of the business	Functional modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical Modularity		Location free Access
Process decoupling							Data Scalability

Les facilitateurs de flexibilité dans le cas du système de Data Warehouse

Conclusion générale

Les résultats des deux études de cas montrent que les éléments qui favorisent la flexibilité ne sont pas toujours les mêmes, ils dépendent des caractéristiques spécifiques du SI. Ceci montre que le caractère de polymorphisme, mis en évidence dans les études sur la flexibilité stratégique, s'applique également à la flexibilité des SI.

La conclusion générale que nous pouvons tirer de cette recherche est que les facilitateurs de flexibilité nécessaires pour un système d'information donné dépendent de la place qu'occupe le SI dans la mise en œuvre de la stratégie, notamment leur orientation (interne ou externe) et le moment où la flexibilité est requise (en relation à la formulation de la stratégie).

La réponse à notre question de recherche (comment atteindre la flexibilité des SI ?) est apportée par l'identification des facilitateurs de flexibilité nécessaires à un SI spécifique. D'un point de vue pratique, cette conclusion se traduit par la nécessité, pour les managers qui interviennent dans la prise de décisions concernant la flexibilité, de comprendre qu'il existe des facilitateurs que l'entreprise peut développer ou acquérir. Cependant, pour doter un SI particulier des facilitateurs pertinents, il est important que ceux-ci soient sélectionnés par rapport aux caractéristiques du SI, notamment sa situation par rapport aux évolutions stratégiques.

Le cadre conceptuel de la flexibilité d'un SI développé dans cette recherche et les résultats des deux études de cas menées sur deux systèmes d'information flexibles, étroitement liés aux stratégies de changement, constituent un guide pour les managers qui souhaitent déployer des SI pouvant s'adapter rapidement à des changements fréquents de stratégie.



FORMATION DOCTORALE

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Abstract

Doctoral Thesis: A contingency approach to IS flexibility

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When changes faced by a firm become increasingly undefined and numerous, it's risky to rely upon conventional strategic management approaches (Volberda, 1997). The increase in changes in industries due to market globalization, rapid technological changes, customization demands of customers, and the life cycles' shortening of products and services can't be predicted. The environment that surrounds these industries (where change is frequent and radical) is label as turbulent (Volberda, 1997). In turbulent environments, firms must quickly respond to the competitive challenges or opportunities presented by the changes. When there is a change in strategies that need to be put in practice, the implementation of changes paired to strategic alignment becomes especially important for firms with large investments in the deployment of IS

because it is relevant to have a tight control on the value that these IS provide. The main question posed when faced to implementing strategies is: how can firms in turbulent environments rapidly adapt and modify their Information Systems when faced with frequent changes in their strategies? The answer is to build flexible Information Systems.

Flexibility represents a firm's responsiveness to competitive pressures and its adaptability to change (Prastacos et al., 2002). It can also be considered as the ability of the organization to adapt to substantial, uncertain, and fast occurring changes in the environment (Aaker and Mascarenhas, 1984). Hence, it is a very desirable characteristic for Information systems when faced to changes. However, enabling an IS with flexibility is difficult to do because of the lack of knowledge on what constitutes flexibility at an IS. There is not a construct, theory or framework that specifies what exactly is meant by deploying a flexible IS to be adaptable to changes. There is also a clear and important gap in the study of flexibility at the IS level that considers what has been found before: that flexibility is polymorphous (Evans, 1995). This means that it displays different forms contingent on specific contextual situations of the IS.

The focus of this research is to study the characteristics of flexibility in order to help building more flexible IS. The objective is to achieve flexibility in the IS in order to adapt them swiftly for facing changes, and be able to adjust for new strategies. The main question posed is: How can IS flexibility be achieved?. This constitutes the research question. This research extends previous studies related to flexibility by focusing on the various dimensions of Information Systems. To cover all the aspects of an IS the problem of enabling an IS with flexibility will be approached, in this research, by analyzing the relevant elements in an Information System. This research will try to identify what IS flexibility is in the people, process, IT, and data dimensions; and how IS flexibility can be achieved.

Flexibility is a term commonly mentioned as being required by every organization and hence flexibility has been studied in a wide range of management disciplines and with several objectives. The common use of the concept in the literature is to bring an answer to problems of rigidity at different levels. Evans (1991) gave the underpinning of the conceptual definition of flexibility and explained the relation of flexibility with similar

terms. His review of the concept of flexibility uncovered many terms that seem to be synonyms (resilience, agility, robustness, versatility, etc.). With all these terms, the evident questions would be: why are there so many related terms? '. The answer lays in a very important hypothesis formulated by Evans: that flexibility is a polymorphous concept. It means that those terms represent different forms of flexibility; the actual form that will stand up for flexibility depends on a specific situation or contextual factors. None of those terms is a single representation of flexibility. This means that those attributes which enable a particular form of flexibility in one situation, are not the same for the provision of flexibility in other situations. On the other hand, Sanchez (1995,1997) found that resources sustained flexibility. That is, resources with certain characteristics (or flexible resources) and the correct use of these resources is what yields flexibility.

Information Systems flexibility has been defined ambiguously in literature (Golden and Powell, 2000) and there is not a universal definition. Nelson and Ghods (1998), Byrd and Turner (2000,2001), and Duncan (1995) have made important contributions to the definition. Another problem discovered in literature is that when there is a reference to an 'Information System' the authors mainly refer to technology and not IS. After reviewing works of authors who have defined IS flexibility one can see that they do not consider that there are many forms of flexibility and just mention factors in relation to flexibility.

The polymorphic nature of IS flexibility demands to have a contingent approach to study it. According to the contingency theory, there are variables that moderate the relationship between variables; for example, the environment. The contingency theory can be applied to IS flexibility; this means that there can be variables that moderate the elements that sustain flexibility.

For the research design, it was found to be suitable to define a conceptual framework to aid the study of IS flexibility with a review of previous work on the subject. The field study consisted on an exploratory study (to extract the point of view of managers that are link to strategies and to changes) and two case studies with IS of different characteristics to test the *hypothesis* that not all enablers presented or identified in the

conceptual framework are necessary for every IS. By comparing two IS with different characteristics it was possible to analyze the ad-hoc form of flexibility.

Conceptual Framework. To build a conceptual framework on IS flexibility a literature review was conducted to extract the flexibility enablers in an Information System. To arrange those flexibility enablers, it was defined in four dimensions: people, process, data and IT. These four dimensions constitute the elements that compose an information system Alter (1996,1999). For its creation the RBV view was selected. It was developed with the aid of the Strategic alignment model of Henderson and Venkatraman (1992,1999) to include the fact that when elements are changed due to a change of strategies, the implementation must be done in an aligned manner. It also considers that the flexibility enablers portrait in the framework are where the implementation of strategies takes

Process Dimension. This dimension refers to two kinds of processes: business and IT. From both flexibility enablers are in the framework.

Skills Dimension. The people dimension in an IS refers to the set of human resources that take part in processes. In this framework, the IS' people dimension is labeled as skills (skills are the capabilities or properties in all the people involved). There are two kinds of skills: those belonging to the people involved in business activities and those belonging to the people working in the information technology activities.

Information Technology Dimension. This dimension refers to the hardware and software that make the IS possible (Alter, 1996,1999). From Henderson and Venkatraman (1992, 1999) it can be deducted that flexibility enablers exist in two aspects: in IS applications and in the technology configuration.

Data Dimension. This dimension of an IS refers to the information used in one or more business processes that is captured, transmitted, stored, manipulated or displayed by the IT (Alter, 1996, 1999). Data dimension was split in two columns because there are flexibility enablers in the data used by the business work flows and in the data manipulated by the IT.

Case study. To answer the question of: how do we decide which enablers are good for each type of system? two case studies closely linked to strategy were selected. The

objective was to compare IS with different characteristics to see what the correct form of flexibility was. In both cases flexibility is very important as strategy implementation is linked to them. But each case has also unique characteristics. The *hypothesis* considered to apply the concepts and assumptions of the conceptual framework in the both cases is that: *not all flexibility enablers are necessary the same for every IS*. The unit of analysis in each case is an Information System; it is described in parts following the format of the four dimensions that constitute an Information System: people, processes, data and information technology. The setting of the case studies is a mobile telecommunications operator. This industry is representative of a turbulent environment faced to many changes.

The conclusion that can be drawn is that the flexibility enablers needed for an Information System are contingent upon its unique characteristics. The findings of both case studies show that the elements that sustain flexibility are not the same for every IS; they depend on certain characteristics of the specific IS. The fact that the elements or enablers needed to sustain flexibility are different can be explained by the polymorphic property of flexibility: for an IS, flexibility displays the same polymorphism characteristic found in strategic flexibility.

The answer to the research question of *how IS flexibility can be achieved*, lies in the flexibility enablers needed for a specific IS. From a practical point of view this means that the managers involved in flexibility decisions or initiatives should understand that there are flexibility enablers in the resources of a firm that can be deployed or acquire. Then, they should become familiar and understand them. But in order to really enable a particular IS with the correct set of flexibility enablers (or the correct form of flexibility needed) it is very important that these enablers be selected according to the unique characteristics of the IS in hand. The conceptual IS flexibility framework developed in this research and the findings presented as a result of two case studies (of two different flexible Information systems tightly linked to changing strategies) conducted, constitutes a valuable guide for managers to deploy flexible IS to rapidly adapt them when faced to changes needed for strategies implementation in a continuous manner.

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Chapter 1 – Introduction

“It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.”

Charles Darwin

Chapter 1 – Introduction

With the advance of technology and its extended use throughout organizations, IS have become a central pillar for them. Some organizations have their operations highly based on Information Systems, that is, they make an extensive use of IS to perform their business processes. For some industries, such as financial and telecommunications, the services offered to their clients are mainly provided by means of costly IS. In this case, applications and infrastructure are packed and offered as services that represent their main source of revenue and profit.

On the other hand, these firms are frequently confronted with changes such as redefinition of strategies (due to the high rate of change imposed by continuous technological developments, shorter life cycle products and increased competition) which, in turn, implies several continuous changes that must be timely implemented at the IS level.

However it is not easy to implement changes into Information Systems because they are difficult to adapt. A clear example of their lack of adaptation is the maintenance problem.

Historically, maintenance has proven to be difficult, too long and costly. Nowadays, due to a higher dependency on IS and the need to quickly adapt them to changes, it is particularly critical for firms to be able to perform agile and timely maintenance on them.

In general, Flexibility represents the ability to adapt to changes. By introducing flexibility into Information Systems, timely and agile introduction of changes is enabled. IS Flexibility then enhances the ability of IS to respond and adapt to a constantly changing environment.

IS flexibility is the topic of interest in this research. The main addressed problem is how to achieve IS flexibility.

1.1 The problem's nature

1.1.1 Turbulent environments

When changes faced by a firm become increasingly undefined and numerous, it's risky to rely upon conventional strategic management approaches (Volberda, 1997). The increase in changes in industries due to market globalization, rapid technological changes, customization demands of customers, and the life cycles' shortening of products and services can't be predicted.

The environment that surrounds these industries (where change is frequent and radical) is labeled as turbulent (Volberda, 1997). In turbulent environments, firms must quickly respond to the competitive challenges or opportunities presented by the changes. Examples of industries in a turbulent environment include the personal computer market, semiconductor industry, and the telecommunication industry.

1.1.2 Change of strategies

The high rate of change in turbulent environments alters the definition of strategies because uncertainty in the future limits the ability of firms to make pre-design strategic decisions (Ansoff, 1978). This means that under these circumstances, the firm has a constant need to re-define their strategies. For example, the companies in the telecommunications industry are undergoing constant transformations in terms of implementing new strategies in response to the ever-changing challenges and demands of this industry (Gunasekaran, Lai and Cheng, 2008).

1.1.3 Change of strategies and its implementation: a strategic alignment perspective

Strategic alignment is based on the fundamental proposition that organizational performance requires a fit between several factors such as strategy, structure, technology, culture, and environment. It is sustained that when there is not a fit (called alignment) between what is defined in a strategy and its implementation (in terms of internal elements used in the firm) the IT employed is not likely to provide the real value it was intended to (Henderson and Venkatraman, 1992, 1999). Several studies have pointed out that organizations whose strategy and IT are aligned, should be less vulnerable to external changes, and should consequently perform better (Bergeron, Raymond and Rivard, 2004; Broadbent, Weill and St. Clair, 1999).

When there is a shift in strategies that need to be put in practice, the implementation of changes paired to strategic alignment becomes especially important for firms with large investments in the deployment of IS because it is relevant to have a tight control on the value that these IS provide. It has been argued that the inability to realize value from IS investments is in part due to the lack of alignment between the business and IT strategies (Henderson and Venkatraman, 1992, 1999).

Under this context it seems critical for firms to consider being able to adapt their IS to implement strategies with limited time, spending in an aligned manner.

The main question posed when faced with the challenge of implementing strategies is: how can firms that confront frequent changes in their strategies (due to turbulent environments) rapidly adapt and modify their Information Systems? The answer is to build flexible Information Systems.

1.1. 4 Flexibility: enabling fast changes

Describing how flexible firms can respond to a variety of changes in the competitive environment in an appropriate and timely way and how flexibility is an answer for the introduction of changes, has been a topic of research (Evans, 1991; Prastacos, Soderquist and Spanos, 2002; Sanchez 1995, 1997; Volberda, 1996, 1997, 1998). Flexibility represents a firm's responsiveness to competitive pressures and its adaptability to change (Prastacos et al., 2002). It can also be considered as the ability of the organization to adapt to substantial, uncertain, and fast occurring changes in the environment (Aaker and Mascarenhas, 1984). Hence, it is a very desirable characteristic for Information Systems when faced to changes.

However, enabling an IS with flexibility is difficult to do because of the lack of knowledge on what constitutes a flexible IS. The studies that have covered the subject of flexibility and IS don't include all the elements that compose an Information System; they have approached the problem partially and not in a holistic approach as has been suggested (Volberda, 1998).

There is not a construct, theory or framework that specifies what exactly is meant by deploying a flexible IS to be adaptable to changes (nor one that includes strategic alignment). There is also a clear and important gap in the study of flexibility at the IS level that considers what has been found before: that flexibility is polymorphous (Evans, 1991). This means that it displays different forms contingent on specific contextual situations of the IS.

1.2 Object of the research

The focus of this research is to study the characteristics of flexibility in order to help building more flexible IS. The objective is to achieve flexibility in the IS in order to adapt them swiftly for facing changes, and be able to adjust for new strategies. The

main question posed is: How can IS flexibility be achieved? This constitutes the research question. From this main research question others that are addressed too: Is there available a standardized and unified concept of IS flexibility? How can IS flexibility be assessed?

As flexibility must be approached by considering all the relevant elements in the problem analyzed (Volberda, 1998), this research extends previous studies related to flexibility by focusing on the various dimensions of Information Systems (in a firm subject to a turbulent environment). Under these circumstances, the introduction of changes must be adequately timed. It also considers the fact that strategic alignment must be maintained in order to maximize the benefits of the large IS/IT investments.

1.2.1 Definition of an Information System

To fully investigate the flexibility of an IS, identifying the characteristics for assessing the flexibility of the elements that conform it is required.

A system is a set of elements or components that interact to accomplish goals. Systems have inputs, processing elements, output and feedback (Alter 1996, 1999; Stair and Reynolds, 2003). An information System is a set of interrelated components that collect, manipulate, and disseminate data and information and provide a feedback mechanism to meet an objective (Alter 1996, 1999). The Information Systems can be manual or computerized. To highlight the fact that it is a computerized system (or that it uses technology), the term computer-based Information System is used. A computer-based Information System consists of hardware, software, databases, telecommunications, people, and procedures that are configured to collect, manipulate, store, and process data into information. The Hardware, software, databases, and telecommunications is usually referred to as information technology (Stair and Reynolds, 2003) or IT. The term people include the Information System's personnel; who manage, run, program, and maintain the system and the users. The users are any

person that interacts with the system to get results. To include a business view point (by making a reference to the business processes that add value to the firm), Alter (1996, 1999) decided to define an Information Systems as systems that use information technology to capture, transmit, store, retrieve, manipulate or display information used in one or more business processes.

To cover all the aspects of an IS, the problem of enabling an IS with flexibility will be approached, in this research, by analyzing the relevant elements in an Information System as extracted from the definition. This research will try to identify what IS flexibility is in the people, process, IT, and data dimensions; and how IS flexibility can be achieved.

It will also address the hypothesis that an integrated and unified concept for IS flexibility is not available already in the literature of IS and also that a valid conceptual framework on IS flexibility enablers can not be designed from IS and management literature at present. It will show how the contingency theory, the strategic alignment model and the resourced-based view provide theoretical elements for developing a valid conceptual framework on IS flexibility enablers.

1.3 Structure of the thesis

The present document is structured as follows:

In Chapter 2, the main elements that have been studied by scholars in relation to flexibility are presented. The findings of a literature review on flexibility are explained; it covers topics that go from manufacturing flexibility (the first field of study), to the latest research on Information Systems and flexibility.

Chapter 3 covers the research design. It explains the articulation of a conceptual framework that was developed in order to aid answering the research question of how to achieve IS flexibility.

It also presents the field study phase conducted as the second stage in the research design. This field work is composed of an exploratory study (to obtain the view of practitioners in relation to flexibility issues) and two case studies (with an Information System as the unit of analysis). The case studies were conducted to analyze, through the conceptual framework, how to enable an IS with flexibility under the hypothesis that not all enablers presented in the conceptual framework are necessary for every IS. The setting of this field study is described in this chapter too.

In Chapter 4, the results and discussion of the exploratory field study are presented. It is explained what the view of practitioners in respect to flexibility issues was. Then, the analysis of the information gathered in the two case studies is shown. It starts by explaining the two Information Systems selected as the unit of analysis for each case study; then, it goes into the findings discovered about each of the flexibility enablers included in the conceptual framework. For each case study, the lessons that are reached with the analysis of the evidence are discussed. A final discussion on both case studies is formulated at the end of this chapter.

Chapter 5 covers the final conclusions. It explains how the present researched managed to bring and answer to the research question, how the results contribute to the knowledge of IS flexibility by using a contingent approach to the problem and by including a resourced-based view. Limitations and future research are also discussed.

***Chapter 2 Literature Review: from
Manufacturing Flexibility to IS Flexibility***

Chapter 2 Literature Review: from Manufacturing Flexibility to IS Flexibility

The term flexibility is widely used in the literature to refer to adaptation; but each use of it doesn't have the same meaning. It is very closely related to concepts such as adaptability, agility, robustness, versatility, elasticity, malleability, litheness and resilience. The term has different connotations that make it easy to be used in many situations and relate it to different problems; at the same time, the broadness of its meaning causes ambiguity (Golden and Powell, 2000).

Flexibility is a term commonly mentioned as being required by every organization and thus flexibility has been studied in a wide range of management disciplines and with several objectives. This chapter explains how the concept of flexibility has been used during the last decades with several approaches. The common objective of in the use of the concept was to bring an answer to problems of rigidity at different levels. Manufacturing was the first domain in which flexibility was defined.

Two different views have been used: a rather deterministic view on the one hand where flexibility is determined by certain elements that must be always present, and on the other, a more strategic view where the elements that determine flexibility are related to the strategy of the firm. From a strategic perspective, IS has also been considered as a resource for the flexibility of a firm. However, IS rigidity has questioned the IS features or characteristics and most researchers have focused on the different IS components whose characteristics influence IS flexibility. The remaining of this chapter gives a view of what flexibility in manufacturing has contributed to the subject, how flexibility has been conceptualized, and the studies surrounding IS and flexibility in a firm.

2.1. Manufacturing Flexibility: Reducing the Sources of Inflexibility

From the 1950's to the 1970's, industries were mainly focused on high-tech research and development and little interest was given to manufacturing. Then, later in the 1980's, the big manufactures and industrial enterprises attention to the Japanese manufacturing techniques that were helping to gain market shares. In this renewal, many elements of production were affected in a movement that embedded the idea of a company "faster, higher and stronger" called the world-class manufacturing (WCM) movement (Schonberger, 1986). Among the primary goals of WCM was to improve flexibility of manufacturing. The benefits of flexibility were not questioned at that time; the problem encountered was to understand and define what the sources of inflexibilities were, so that production could be simplified and improved. In the 1980's and 1990's, flexible manufacturing systems philosophy (FMS) (Viswanadham and Narahari, 1992) was developed as a competitive manufacturing strategy. FMS is suited for unpredictable market environments that demand low-cost solutions for quickly and effectively adapting to changes in product mix, demand and designs. The main idea is to have a manufacturing system able to survive several product life cycles, to sustain desired levels of production of various part types, and to change design, demand and product mix.

An FMS can be defined as an integrated computer controlled configuration of machine tools, other production equipment and a material handling system designed to simultaneously manufacture low to medium volumes of a wide variety of high quality products at low cost. Four types of flexibilities were defined: 1) Machine flexibility is the ease with which a machine can be set from one part type to another; 2) product flexibility is the ability to change over to new products economically and quickly; 3) routing flexibility is the ability to produce the given set of part types in required volumes

in the face of failures or breakdowns; and 4) Operation flexibility is the ability to interchange the ordering of the operations required to produce a particular part type.

Manufacturing flexibility has been explored on several points which include: production equipment characteristics, product design, work organization, planning and control procedures, materials management, and product change over. The production process itself has been explored deeply and several philosophies (including FMS described above) can be found. At this level, one of flexibility's concerns is with designing specific methods of handling changes in production of different products or the variety of products a manufacturing plant can produce. For some companies it is desirable to be able to produce a broad range of products instead of only one. To supply a range of products in one plant, the manufacturing process should permit to switch from a product being manufactured to another (as in product flexibility).

It is also desirable that these changes are adequately timed and that the plant can respond on time. This can be achieved by building capabilities, including flexibility, which allow the manufacturing plant to switch effortlessly and quickly between products. The changes can be caused by diverse internal circumstances such as breakdown of equipment, worker absenteeism and quality problems, or external circumstances such as changes in demand, market or design. At the operational level, the changes involved are internal; in this case, flexibility constitutes an internal ability that is fundamental to achieve competitiveness. For example, if an enterprise has a service level policy of keeping the customer's due dates, then they would have to be able to manufacture the same volume even if they face failures or breakdowns. For this problem, flexibility could mean to have options for rerouting the production. Another example is the situation when an enterprise is faced to changes in the characteristics of the material; to maintain a product quality they can be flexible by enabling their production to change the material used. In both examples, the response to changes involves an internal ability.

2.1.1 Determinant approach

The first concern of researchers was to find the determinants of flexibility. For example, Upton (1994, 1995, 1996) conducted studies with the objective of finding the specific characteristics of a manufacturing plant that supports the ability to change the product being manufactured. In his study, flexibility is related to responding to changes in production. He specifically focused on the ability of a plant to be flexible in making product changes; that is, the speed of a plant to change production from one product to another.

He observed that the time employed for changing the products varies a lot among manufacturing plants of the same industry. For his study, he selected the paper industry because it is characterized by a growing demand in broader product ranges and the production process is basically the same in every manufacturing plant. He researched with data gathered from fifty-two plants in the North American uncoated fine paper industry over a period of two years. His definition of flexibility is ‘the ability to change with little penalty in time, effort, cost or performance’. The determinants are the specific factors that enable flexibility. The different products manufactured in paper plants are basically a range of different types of paper.

Upton’s research was the identification of factors affecting rapid process changes. The determinants for rapid change fall into four categories: Plant operations policies (such as the frequency of changes in raw material); plant structure (such as the scale and age of the machinery and the production speed of the plant); plant infrastructure (such as the experience of the work force and the degree of computer integration) and managerial emphasis (such as the extent to which operators felt they were being encouraged to change quickly). To assess the relative importance of the determinants and categories he defined several models. The models showed that the only important variable important in determining change times is the production speed of the plant

(which is a factor in the plant structure category); faster machines make changes more quickly.

No relation was found with the size or scale of the plant. This finding also contrasts considerably with the general view of plant managers in the industry that large plants are less flexible and more difficult to change.

Another finding in the study concerns the strong negative relationship between changing components of the paper and the personnel involved. Possible causes (which could not be proven with the data he had available) are that, in general, the crew is very experienced but mature personnel and old age is not in accordance with the physically arduous task of changing the paper.

The work of Upton (1994,1995,1996) provides a foundation to know that there are different determinants for rapid change in each category found.; that is, there are different sources of flexibility in different levels.

From Upton's findings and research one can think that at the IS level, the determinants of flexibility exist in several domains and they all must be considered. The categories and determinants found for the manufacturing domain could be viewed as follows for the IS domain: The manufacturing plant operation policies correspond to the rules or policies set by the management for the operation of the applications. For example, in a billing system, there are rules and policies that define the date of the month in which the bills should be generated. Those rules and policies can be determinants of flexibility because they can be set and oriented to allow the billing at any given time.

The plant structure, in the manufacturing domains, corresponds to the characteristics that yield a processing speed of the infrastructure, networks, servers and applications.

The plant infrastructure or speed of the work force would correspond to the speed of work of the IT personnel. The degree of computer or integration is also part of the plant infrastructure in Upton's research. In the data level, this corresponds to the data degree of integration. It would be a determinant because when data is correctly integrated in a database it is easier to change it.

The managerial emphasis or the extent to which operators felt they were being encouraged to change grades quickly, correspond, in the IS domain, to the IT personnel skills and training to perform several functions (and thus be able to change as required) or to the users capacity to use different systems or applications. Upton's work finds also that there are variances (not explained by the statistical analysis performed) in the flexibility across the manufacturing plants used in the empirical study that are unlikely to be the result of random errors in observations and thus points to the need to find additional factors that make a plant flexible. From this observation, one could think that there could also be variations in the flexibility of an IS. And that the different systems (even inside the same firm) could display different determinants of flexibility. Upton's work focused only on flexibility to respond to changes in the product being produced. This view constitutes an operational level of manufacturing that was deemed to enable plant managers to offer a broader line of products or to introduce new ones. But managers were still confronted with the question related to the correct kind of flexibility that they should seek in order to respond to uncertainties related to market demands (such as length of product life cycle) and product manufacturing (such as machine downtime). To face this question other studies focused on the ad-hoc manufacturing flexibility needed for supporting strategies designed to respond to uncertainties, these studies, that focused on flexibility depending on the strategies, constitute the strategic approach.

The strategic approach is based on strategic planning, whose goal is to produce strategies that will constitute the firm's guide to operate in the market. Strategic planning requires the execution of a market and environment analysis that includes the present threats from potential entrants and substitutes and the bargaining power of suppliers and customers. The complexity in producing strategies lies in the fact that neither the market nor the environment can be taken as static, thus uncertainty is always present. Formal strategic planning was first introduced in organizations in the mid-1950s. At the time, only the larger companies had formal strategic planning exercises. By the 1960's

the uncertainty of the markets was increasing even more due to more complex engagements that produced more variables to consider when planning.

The more important uncertainties were those related to the unforeseen events having high impact on the firm. These uncertainties made strategy formulation a more difficult task. It also led the firms to the need of coping with reformulating the strategies more often. Faced with this problem, in the 1970's the concept of flexibility started to be related to strategy formulation in a search to make the procedure more agile.

For this organizational use, flexibility is associated with an ability to respond to market opportunities and uncertainties, to technological development and customer demands by swiftly shifting to another strategic option. The various strategic options that a firm can produce constitute its capacity to adapt management decisions from some course of action to another. This connotation of flexibility is referred to as strategic flexibility and is part of the strategic approach. Strategic flexibility is closely linked to the management of uncertainty. In the presence of dynamic or turbulent environments a firm can benefit by creating strategic flexibility in the form of alternative courses of action (or strategic options) for reacting to the encountered uncertain events. The next section explains in more detail the strategic approach and its link to flexibility.

2.1.2 Strategic approach

Upton's determinant approach focused on the exact factors that determine flexibility. It should be noted that his study was conducted only in one field which was the paper industry. A less deterministic approach is to consider that different forms of flexibility should fit the firm's strategy. In general, a strategy is a pattern of concerted actions taken to create value for a firm by improving its economic or overall performance. If these actions are planned and designed at the top of an organization structure, then it is strategic management and the result is a corporate strategy. Strategic management

provides guidance, direction and boundaries for operational management among which strategic aspects and decisions for manufacturing.

At this level, flexibility is concerned with handling uncertainties due to external conditions (such as market related issues) or related to manufacturing process. In general, management must learn to cope with both internal and external uncertainty. At internal or external levels, a present element is the orientation on how to focus: reacting defensively or acting proactively. Manufacturing strategies denote the orientation on how to act: attempt to defensively adjust to uncertainty or proactively control it. Flexibility is required, whether the strategy's plan is defensive or proactive.

A common approach to flexibility is that managers plan the manufacturing strategies and then develop the required manufacturing flexibility; this approach is defensive in nature, as it adjusts to a particular uncertain environment. This use of flexibility is seen as adaptation. Flexibility may be employed proactively too to redefine competitive conditions.

For example, **Gerwin (1993)** took the common approach of developing strategies first and then incorporating the flexibility needed (to sustain those strategies) to analyze manufacturing flexibility from a strategic point of view. For him, the planning of strategies should be based on the type of uncertainty faced including uncertainties due to the market or to the manufacturing process. His approach tends towards finding flexibility enablers because once the strategy was established; he identified the elements that constituted flexibility for that particular strategy. Thus the type of flexibility should be related to the type of uncertainty as shown in table 1.

	<i>TYPE UNCERTAINTY</i>	<i>OF</i>	<i>STRATEGIC OBJECTIVE (uncertain reduction method)</i>	<i>FLEXIBILITY TYPE (adaptive method)</i>
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Uncertainties related to the market	Market acceptance of kinds of products	Diverse product line	Mix
	Length of product life cycles	Product innovation	Changeover
	Specific product characteristics	Responsiveness to customers' specs	Modification
	Aggregate product demand	Market share	Volume
Uncertainties related to manufacturing process	Machine downtime	Customers' due dates	Rerouting
	Characteristics of materials	Product quality	Material

Table 2.1 Uncertainties and flexibility types; adapted from Gerwin (1993).

The first four rows correspond to uncertainties related to the market because they are uncertainties in the demand for products. The next three rows are manufacture oriented because the uncertainties shown exist in the manufacturing technology or its inputs. Each row shows a possible situation that could occur (an uncertainty), a strategic solution to face that situation and the flexibility needed to implement the strategic objective and thus, react to the uncertainty.

For example, to be prepared for the event that the market demands a different product (market acceptance of kinds of products), a strategy of diversifying the product line should be formulated (diverse product line); to sustain that strategy, the production should be able to handle the production of a range of products (mix).

In the presence of uncertainty about the length of a product life cycle, a strategy of innovating in the product is ad-hoc; for that aim, the ability to quickly change over to a new product is adequate. Each type of flexibility in the last column (mix, changeover,

modification, volume, rerouting, material, flexibility responsiveness) is considered to have two aspects: range and time.

One production system is more flexible than another if it can handle a wider range of possibilities (to vary production through a greater range of volumes). A production system is also more flexible than a second if it can attain a new possibility in the range in a shorter period of time.

Each type of flexibility in the last column (mix, changeover, modification, volume, rerouting, material, flexibility responsiveness) is sustained by specific factors that can be considered as the flexibility enablers. The detail of each type of flexibility in Gerwin's (1993) work is the following:

Mix: represents being able to handle a range of products or variants with fast setups. The range aspect signifies the extent of product variety; the temporal aspect reflects setup time. The mix flexibility, is an alternative to "focus manufacturing" where the orientation is towards the specialization to reduce costs. The disadvantage of focus manufacturing is the threat to being unresponsive to market.

Changeover: ability to quickly substitute products. The range aspect indicates the variety of major design changes which can be accommodated, while the temporal aspect refers to that portion of new product introduction time which occurs in the manufacturing function (manufacturing startup time).

Modification: Modification flexibility allows a manufacturing process to implement minor design changes in a given product. The range aspect reflects how many different kinds of minor changes are possible, while the time component indicates the speed with which a given change is accomplished. This type of flexibility is associated with the strategic objective of responsiveness to customers' specifications.

Volume: volume flexibility permits increases or decreases in the aggregate production level. The amount of change reflects its range aspect, while the length of time to make a change represents the time aspect. A need for volume flexibility occurs in response to uncertainty in the amount of customer demand.

In the work of Gerwin (1993) it is noted that different types of uncertainties, (which are uncertainties related to market and production) call for different strategies and different forms of flexibility. Uncertainties due to the market acceptance of products in manufacturing come from outside the firm. For Information Systems, the outside boundaries could correspond the users' business units which would be the sources of uncertainties for the IS. The manufacturing uncertainties, that are internal, would correspond for IS to uncertainties related to technology. It is also feasible to relate the forms of flexibility in production (mix, changeover, modification, volume and rerouting) to the IS domain.

The mix flexibility type (which represents to be able to handle a range of product or variants with fast set up) could be related to the capability to add new functionality to an application, which is a maintenance aspect of the IS. The ability to quickly change products, referred as changeover in Gerwin's (1993) work, is an ability that also exist in the IS level, an example of that is an insurance system designed to handle car insurance policies but that it could also have the capacity to easily support the provision of insurance policies for homes.

Modification flexibility refers to allowing minor design changes in a given product in manufacturing, this could mean for IS, a maintenance aspect too as it is related to the flexibility needed to respond to a user's request for including in a system new technology they know and desire to use. For example, the requirement to add a touch screen to input data, or a graphical interface to display outputs.

The volume flexibility type in manufacturing, means, for IS, the capacity of an application to handle and process more transactions. The volume flexibility type in Gerwin's work is recommended for the strategic objective of keeping a market share. For an IS, the market share would correspond, in the IS domain, to the business unit whose acting as a client. In this case, the IS department would have as a strategic objective to support the business activities of their clients.

When faced to a machine downtime, Gerwin suggests that the correct flexibility type according to that uncertainty is rerouting. For IS, this uncertainty would correspond to technology malfunction or machine downtime. In this case the flexibility type for IS would call for capabilities to back up applications and technology. In manufacturing the uncertainties related to characteristics of the input material call for flexibility in changing the material used. For IS that would mean, to be able to change the technology provider or the external technical human resources (as they constitute the external material or input) by means of diversifying providers relations. The conclusion can be that different forms of flexibility in the IS are required according to the types of uncertainties faced.

In prior sections it was shown that manufacturing flexibility has been approached in a deterministic way and that there is also a link to flexibility in the strategic approach. The determinant approach of flexibility has focused on a precise point: how to manage with changes in the products manufactured. The strategic approach focus on uncertainty, that calls for different kinds of flexibility.

Another major contribution to the understanding of flexibility has been made by researchers who have tried to define more precisely the concept of flexibility,; some of these works will be explained in the next section.

2.2 Conceptualizing flexibility

In last decades, the increasing changes in business environments have required rapid responses from the firms, and their ability to reformulate their strategy when needed. This is why the concept of flexibility has been used to characterize a capacity of some enterprises. From this point of view, which is broader than just a manufacturing view, it was necessary to have a definition of flexibility that could be used at an organizational level. Evans (1991) gave the underpinning of the conceptual definition and explained the relation of flexibility with similar terms.

2.2.1 Polymorphous concept

Although the benefits of strategic flexibility were clear after the work presented before, a construct was needed. Evans (1991) devoted his work to the conceptual underpinning of the term strategic flexibility. The objective of this work was to clarify the concept of flexibility by pointing out the differences between flexibility and several related terms.

The setting of his study is a high technology intensive environment (he specifically analyzed a sub-segment of a computer industry: a peripherals computer firm) because it is surrounded by many uncertainties that make strategic flexibility a need. The research approach is on the qualitative vein by the use of three field studies conducted in consecutive phases.

His review of the concept of flexibility is very thorough with the inclusion of terms that seem to be synonyms but those are really terms with similarities but and also differences. The constant in all of them is that they all refer to a characteristic to remain viable when faced to external changes or to a capacity to redefine a posture. For example, flexibility is a successive series of adjustments. Adaptability differs from flexibility in the sense that it implies singular or permanent adjustment to a newly transformed environment.

Resilience is related to flexibility because it implies a tendency to rebound or recoil showing recuperative power and a capability to withstand shock. Robustness refers to a system's ability to absorb or endure the impact. Versatility is achieved by either installing a capability to respond to a wide range of scenarios ahead of time, or by affecting a rapid modification once a change has occurred. Elasticity also fits the sense of flexibility as in resilience, (tolerate infliction and return to normal state) as it implies susceptibility of modification. This sense is also present in liquidity; it denotes that assets can be converted with minimal friction to another form without incurring in switching costs.

With all these terms mentioned, the evident questions would be: ‘why do we need so many terms for defining flexibility?, why are there so many related terms?’. The answer lays in a very important hypothesis formulated by Evans (1991): that flexibility is a polymorphous concept. It means that those terms represent different forms of flexibility; the actual form that will stand up for flexibility depends on a specific situation or contextual factors. None of those terms is a single representation of flexibility.

For example: versatility is associated with a capability to respond to a wide range of scenarios; this can specifically be the capability to produce a range of products. Versatility would stand for flexibility if the setting is a manufacturing plant faced to uncertainties in the market demand or in the consumer acceptance of a product where many products might need to be produced.

This means that those attributes or capabilities which enable a particular form of flexibility in one situation, are not to be the same as, transferable to, or appropriate for the provision of flexibility in other situations. This finding is very important, because it is the first work that explains the existence of many flexibility related terms by identifying a tight link between contextual factors and a specific form of flexibility.

As the context or situation is tightly link to a singular form of flexibility, to conceptualize strategic flexibility it is required to define the setting being analyzed. A suitable setting for strategic flexibility can be the strategic behavior of a firm. This behavior or conduct would show if a firm engages in a defensive or offensive *modus operandi* and if their actions/reactions are prior or post the appearance of an event.

For Evans (1991), two dimensions conform the strategic behavior: intention and time. The intentional dimension refers to the attitude of a firm for competing: this attitude can be offensive (characterized by the preference of creating an initiative before other competitors do) or defensive (where the operand’s preferences lean towards guarding against moves or initiatives of others). Temporal dimension concerns with the selected timing for the actions (or responses) of a firm with respect to the happening of any triggering event (that is, an uncertain situation encountered).

Enterprises have two main choices for selecting response timing: the first is responding or acting after a triggering event; in this case it would constitute an adjustment situation. The second choice is preparing in advance of a triggering event. The temporal and intentional dimensions are identified and selected by Evans (1991) as suitable for defining a conceptual framework. The framework is shown in table 2.2.

		<i>Temporal dimension</i>	
		<i>EX ANTE</i>	<i>EX POST</i>
<i>Intentional dimension</i>	OFFENSE	Agility versatility	Liquidity Elasticity
	DEFENSE	Robustness Hedging	Corrigibility Resilience

Table 2.2 Integrative Framework of strategic flexibility; adapted from Evans 1991.

In the framework the temporal dimension is portrayed as two columns. The first (ex ante), refers to the strategic decision of preparing for future events, the second (ex post) is the strategic decision of preparing to respond after events. The rows of the table are the two modus operandi, offense would indicate that the firm is aggressive and tries to control the market by being a first mover (creating initiatives before others do) or defense that would indicate a protective behavior for responding to initiatives of other firms. Columns and rows show the strategic behavior as characterized by the two dimensions.

The four combinations of the intentional and temporal dimensions show all possible forms of strategic behavior. To each form of behavior corresponds a particular form of flexibility: each situation determines the proper form of flexibility needed. For example,

if the strategic behavior of a firm is offensive and ex post, the form of flexibility suitable for that firm under those conditions is liquidity or elasticity. Elasticity would enable the firm to tolerate infliction and return to a normal state; this is needed to respond to events after they happened. Liquidity means that asset can be converted to another form without incurring in switching costs; this is a good ability as the firm can plan and deliver new moves in the market.

This framework shows how a particular form of strategic behavior determines the flexibility needed; depending on the context or setting is the ad-hoc form of flexibility. Each term in the matrix is a form of flexibility; terms are alike but each one covers only certain aspects of flexibility. A specific term is adequate depending on the current setting or circumstance.

But what does this mean for Information Systems? The notion of having different forms of flexibility is suitable for the IS level too. The different forms of flexibility can have a correspondence with dimension in the IS. The correct form is also related to the specific factors or contextual situation: they can be linked to the strategy, as in Evans' work or other contextual situation.

The ex-ante and ex-post dimensions can have a correspondence in the following argumentation: the ex-ante or offense position would mean in IS to already having the capacity to make changes. In this sense, the system is already prepared. The ex-post or defensive position would imply that the system can be changed easily, or to be able to adapt to new functions in a certain time. For IS, the offense and defense aspect do not have the same business strategy connotation as in the firm's strategic management level in the work of Evans; the decision of enabling an application to be offensively or defensively prepared must come from the IS management but in alignment with to the global business strategies.

For preparing or anticipating to an event, the system can have certain characteristics that would correspond to a suitable form of flexibility to be prepared in advance or to respond. Characteristics that stand up for preparing or responding are not the same.

Table X shows the forms of flexibility researched by Evans with a suitable correspondence of what would correspond for an IS.

<i>Form of flexibility</i>	<i>Description of the form of flexibility adapted to the IS level</i>	<i>Form of Flexibility suitable to be prepared before an event (ex-ante) or after (ex-post)</i>
<i>Versatility-agility</i>	A way to be flexible in a versatile is by developing a range of options before they are needed. In this case, the benefit is the capability-based developed for pursuing different alternatives. This could be, for example, by means to design a product so it can be upgraded for new needs. An example for the IS, would be to have , in an application, the capabilities needed to offer a new service before it is actually needed. For the people dimension, versatility could stand for multiskills.	Ex-ante
<i>Robustness- hedging</i>	Hedging and robustness are needed in the presence of extreme variation in competitive intensity or entering a new business. In this uncertain situation about the future, an insurance or hedge is important (before a probable event happens) to enable the company to continue to operate. For example, in the expectation of a rapid market grow, a company may decide to acquire another firm. For a peripherals company, where the supplies of components is critical, they could decide to contact a second source of components if they think they can be faced to a supplier disruption. For an application, it could also mean an insurance or protection for events before they happen (ex ante) and the capacity to	Ex-ante

	absorb impact for several reasons in the form of additional resources (disk space or processing elements estimated in excess) or functions program before needed.	
<i>Resilience- Corrigibility</i>	These forms of flexibility are suitable for past mistakes, predatory competitive moves or accidents. It is a capability to recover from infliction. An IS is resilient if it has functions to recover (such as back up systems or functions) or with a capability to be easily modified (as the plug-in of new modules and suitable interfaces). Corrigibility in IS can refer to maintainability or capacity to modify easy the software, processes or machines and small maintenance to correct bugs.	Ex-post
<i>Liquidity- elasticity</i>	Liquidity/Elasticity are suitable forms of flexibility, after events have occurred when, there is a need to take advantage. (i.e when there are new standard established in the industry.) For an IS this could be the capacity to add new functions after an event has occurred, to the ones already present, easily.	Ex-post

Table 2.3 Polymorphous view of flexibility for IS.; Adapted from Evans 1991.

2.3 Flexibility from a Resource Point of View

The flexibility of the firm is founded on its resources and the ability to use them correctly; that is why some authors have researched on these two topics. The perspective that is founded on resources of the firm is the RBV, its main proposal is that the specific internal factors called resources that are used in their operations and explain variations in the performance of organizations (Peppard and Ward, 2004).

2.3.1 Resourced-Based View

In the resource-based view (RBV), resources play an important role to the performance of the enterprise. This view argues that firms own and deploy certain resources to gain and sustain competitive advantage and long-term performance (Barney, 1991; Wernerfelt, 1984). A basic assumption of RBV is that resources are distributed heterogeneously across organizations; this means that they are internal factors specific to a firm. According to RBV, this firm-specificity explains the variations in performance across organizations in the same industry.

Although the resources are specific to a firm, in order to sustain advantage they should be rare, imperfectly mobile, and non-substitutable in other word, only if they possess certain characteristics. Wade and Hulland (2004) explain in detail the characteristics that resources must have according to a resource-based view (RBV) to sustain advantage.

The first characteristic is value; a resource has value when it enables a firm to implement strategies that improve efficiency and effectiveness. The second is rarity; it refers to the condition where the resource is not available to a large number of firms. For example, a software package may be important to a firm but it does not provide strategic benefit as it is not rare. Another characteristic is appropriability; it refers to the resources' earning potential. For example, the technical skills of a human resource yield the company with value if they are used in a way that generates revenues. If a salary is too high (vs. the benefit produced by the worker), then the human resource has low appropriability. The next characteristic is imitability; it is the degree in which the resource can be imitated. Resources are harder to imitate when they have implicit things inherent to the company such as the understanding of which resources to use and how. Another factor that influences imitability is the social complexity between the firm and suppliers and customers.

Substitutability is also a characteristic; it refers to the existence of equivalent resources. Excellence in software development, systems integration, technology scanning are resources difficult to substitute. Mobility or non-tradable is a characteristic that makes the resource not easy to obtain. Computers and hardware in general are relatively easy to acquire; company culture, brand assets are only available to the firm. This implies that the firms should protect against resource imitation, transfer or substitution.

In general, assets and capabilities define the set of resources available to the firm. Assets can be tangible and intangible; capabilities transform inputs into outputs of greater worth (Wade and Hulland, 2004). Central to the RBV is the fact that resources, per se, do not create value, it is created by an organization's ability to utilize and mobilize those resources.

The RBV is suitable in the IS level to look at resources belonging to IT. It provides a suitable way to evaluate how IS resources relate to the firm's performance. Resources at the IS level under the RBV have been considered as necessary but not sufficient to sustain a firm's advantage because IS assets such as infrastructure are the easiest resources for competitors to copy and, therefore, represent a fragile source of competitive advantage. They rarely act alone in attaining or sustaining advantage. Instead, they form part of a complex chain of assets and capabilities that may lead to sustained competitive advantage. For example, a given technology has strategic value only if it is paired with IT human skills to apply it innovatively. This characteristic of IS resources is known as complementarity. Complementarity is the way a resource influences another and how the relationship between them affects competitive position or some performance measure as flexibility. The fact that IS are viewed under RBV as complementary assets implies that IS have a more complex role within the firm than other resources.

2.3.2 Link between flexibility and resources

Some researchers have tried to identify the link between flexibility and the resources of a firm. This is, in general, a view where resources take the form of flexibility enablers. For example, Sanchez (1995, 1997) 's study is aimed at finding how enterprises can deal with uncertainty. His work shows that to face uncertainty it is useful to create a range of strategic options to respond. But the creation of a range of options require that the firm has access to flexible resources and be able to use them in alternative uses; that is, to have resources that can enable flexibility and to be able to use them correctly to yield flexibility. The resources can be of human, physical, and information type.

According to Sanchez, a resource's flexibility is determined by its potential uses. There are three ways in which a resource can be a 'flexible resource'. The first is when there is a larger range of alternative uses to which the resource can be applied. For example, when a resource can be used to develop, manufacture, distribute or market a range of different products.

The second option is when the costs and difficulty of switching from one use of the resource to an alternative use are lower. An analogy to exemplify this option can be found in a production line where the flexibility increases as the cost of switching from one product to another decreases.

Finally, a resource is more flexible if the time required to switch to an alternative use is lower. This implies that managers would need to identify and acquire flexible resources that can be used in the above options; but the final result for flexibility depends on the firm's understanding on these alternative uses of resources, the costs, difficulty and time required to switch them. The understanding would lead to an effective use of resources for flexibility objectives; this constitutes what Sanchez calls 'coordination flexibility'.

Coordination flexibility is the link between flexibility in the resources and the firm's ability to use them effectively through new strategies. Coordination flexibility refers to the

creative side of the company as this involves the definition of strategies to develop products and target markets; configure the resources for the product and market and finally the deployment through the organizational resources.

Coordination flexibility, as described by Sanchez, involves three main activities:

1) Defining the uses to which the firm's resources will be applied. This activity refers to setting goals on how the resources will be strategically used; for example, this task would analyze the products that will be manufactured as defined in the marketing strategies;

2) Identifying and structuring chains of resources capable of being applied in the uses targeted by the firm. This activity reflects the ability of the firm to identify resources and link them in a certain arrangement that can lead to reaching the strategic uses defined in step 1. In management terms, this activity, is the assignment of resources to a value chain. For example, once the products to be manufactured are established, the firm would need to identify from their pool of resources the ones that are needed to produce them.

3) The last activity involved in coordination flexibility is the deployment of resources to the targeted use. This implies that through the organizational processes, the resources should be effectively applied to the given strategic objectives. These three activities are important, as they are the real link between resources and its effective management.

For Sanchez (1995,1997), resource and coordination flexibility (the characteristics of resources per-se and the way they are used) represent equilibrium in adaptation. The constant need for adaptation is because the resources and capabilities to use them are temporary; there is no specific resource that results in permanent advantage, there are always uncertainties in the market.

Resources must be flexible and the firms should know how to effectively use them with an increase range of possibilities and a decrease in cost, difficulty and time required. The idea that resources' flexibility is determined by its potential uses can also be related to the Information Systems level.

There are different way of how to deploy a larger range of uses for IS resources. Multipurpose applications, multiskills in people, extensive and continuous training (in new technology or business issues) are characteristics that allows a resource (human or technical) to be uses for different purposes. Highly parameterization in an application or data is another example of these characteristics. Data highly standardize enables to be used for several alternatives uses because the same structure is handled and understand by several entities. For example, banking systems that exchange information where each bank knows the data standardization to enable exchange but is able to define the data usage.

As any other resources, IS resources must be wisely used for flexibility purposes. The IS manager would have to possess or develop managerial skills to do it. These skills are oriented towards defining uses to which the IS resources will be applied, identify and structure them in a certain arrangement or the deployment of resources needed.

Coordination flexibility means, for IS managers, to make correct decisions to manage IT resources. For example, if certain resources in the people dimension would be assigned to more than one activity or role, then multiskills development should be pursued by IS management as it is a good characteristic that would permit several alternative uses of a human personnel. This multiskills characteristics could be developed by rotating personnel to different applications, system or business units or by investing in training. Coordination flexibility implies for IS managers several complex abilities too; that can be exemplified in the decision to outsource a process or application. For this, the manager would need skills to make the correct decision on what to outsource, selecting a provider, then develop an accurate requirement for the outsourcing company of the description of the process, and the capacity to accurately define the scope.

Sanchez (1995,1997) gives us important argumentation to raise the need to look at the resources of a company for sources or enablers of flexibility.

Scholars started to apply the theories of the RBV in the mid-1990. RBV has shown that there are many components on which flexibility can be sustained. In general for a firm,

resources are assets and capabilities that are available to a firm and useful in responding to market opportunities or threats.

Following this resource based view (RBV) for Information Systems, there are IS assets and IS capabilities too. IS assets can be tangible (like hardware, network infrastructure, applications, etc.) or intangible (software patents, vendor relationships, etc.). IS capabilities transform input into output (i.e. skills, managerial abilities, processes, system integration, etc.).

Wade and Hulland (2004) adopted a RBV to analyze IS flexibility: in their work they did not provide with an IS flexibility definition. Mainly, their work consisted on the identification of a list of IS resources by analyzing previous work that used a RBV for the study of IS. They identified several categories of IS resources. These categories are shown in table 2.4.

The main idea portrayed on the table is that there are categories of IS resources that contribute to the flexibility of the firm because they make external relationship management, IS business partnership, market responsiveness, etc. These categories show resources in the IS that help in the flexibility of the firm.

<i>Category of IS resources</i>	<i>Description of the category</i>
External relationship management	Represents the firm's ability to manage linkages between the IS function and stakeholders outside the firm.
Market responsiveness	Involves the organization's response to a collection of information from the outside.
IS business partnerships	Represents the processes of integration and alignment between the IS function and other functional areas or departments of the firm.
IS planning and change management	The capability to plan, manage and use appropriate technology architectures and standards. The ability to anticipate future changes and grow to choose technology that accommodates this change.

IS infrastructure	Hardware and software
IS technical skills	IS technical skills are a result of the appropriate, updated technology skills, held by the IS/IT employees of a firm. This includes the ability to use, deploy and manage that knowledge.
IS development	Capability to develop or experiment with new technologies.
Cost effective IS operations	Ability to provide efficient and cost- effective IS operations on an ongoing basis

Table 2.4 Information Systems resources' categories; adapted from Wade and Hulland 2004

2.4 IS and the firm's flexibility

Flexibility related to IS started to be explored in relation to maintenance problems. In the 1970's constantly ill defined requirements caused that the software applications needed to be modified several times; producing delays, over budgets and difficulties in defining deathliness for the delivery. People involved in the development of applications started to explore new efficient ways to adapt the systems to accommodate changes in the specifications. So the issues of flexibility were mainly grounded in the problems associated with maintenance. Software engineering techniques improved the structural quality of software but did not address the problem of rapidly changing specifications or implementing new requirements. This was a problem of software flexibility and agility rather than structural quality. In firms in turbulent environments, where there are unexpected changes, this was a problem across most of the software platforms and thus became a concerned of CIO's in the IT units. The problem with technology was the rigidity to change it.

The work whose topic is flexibility in relation to IS/IT is one of the most recent applications of flexibility. There have been some references of specific IT issues or components related to sources of flexibility, for example, the mention of special IT

architectures that provide the foundation for rapid response to changing market conditions or new technology in the hardware elements and development paradigms (object oriented, prototyping, and novel design issues) to allow more flexibility in the development of IS. Several contributions to flexibility in IS are presented in following sections and a paradox related to the positive and negative aspects of the IT elements contributing to of flexibility are presented.

2.4.1 IS Resources as a support to the firm's flexibility

Zhang (2006) investigated the role of IS as a support to strategic flexibility. Although he uses the term IS, the study is really focused on technology resources and not IS. He concurs with Wade and Hulland (2004) in the fact that firms with unique and difficult to imitate or substitute resources and capabilities can gain and maintain competitive advantage. One organizational capability that is hard to copy is strategic flexibility.

IS as a resource has a supporting role in strategic flexibility: firms that use IS to support strategic flexibility generate competitive advantage. For example, in advance manufacturing technologies (AMT) computer aided design systems (CAD) are used to support rapid prototyping that enables the firm with the capacity to quickly design any range of parts or products within a family. Another example is a financial services firm that used their expertise on developing financial products to design software modules that automate the task. This allowed them to handle a greater variety and range of customers at higher speed.

For Zhang (2006), IS are resources that do not generate advantage per-se; they have only a supporting role, because they help to attain strategic flexibility. For him, as for Wade and Hulland (2004) IS are complementary resources, or resources whose presence enhances the value of other resources. He comes to this conclusion because IS have characteristics of commodity-like resources. Commodity-like resources lack the characteristics of being unique or difficult to imitate and so, can not generate or sustain

competitive advantage. They are unlikely to have any direct impact on firm performance.

Besides their supporting role in strategic flexibility, IS resources are important because firms that complement their organizational competencies with IS may be able to create a complex set of complementary resources that are difficult to match. Zhang (2006) observed, for example, that firms that merged their IT with complementary human and business resources enjoyed higher levels of performance than firms that failed to do so.

However, the strength of the relationship of IS support for strategic flexibility and firm performance is likely to vary across firms. Zhang (2006) found that value of the resources of a firm are contingent upon market context; the stability or uncertainty in the environment affects the value of the resources of a firm. For example, a study of film studios showed that resources such as exclusive long-term contracts with the actors improved financial performance only in a stable environment.

A central point in his findings is that strategic flexibility may not confer equal value to firms under different external conditions. A special case of the so called external conditions are constituted by the environmental dynamism which is the factor that he selected to analyze its influence. The environmental dynamism describes the rate and the unpredictability of changes in a firms' external environment.

He made the hypothesis that the high degree of dynamism (which is a contextual situation) has a positive influence in the support of flexibility for a firm's operational efficiency. To evaluate the hypothesis he adopted several items to measure the three variables involved: IS support for strategic flexibility was the independent variable, the environmental dynamism the moderating variable and the return on sales (or ROS which is a classical profit-ratio used to evaluate a company's operational efficiency) the dependent variable. Statistics results showed the support for the hypothesis.

His finding implies that the strategic flexibility given by IS resources is of greater value to the firm when the external environment is highly changing. This brings evidence that flexibility is particularly important for the performance of the firm when the environment

is dynamic (but the role of IS resources is unclear). The pursuit of flexibility calls for a close alignment between resources used and the rate and unpredictability of changes in a firm's external environment.

As IS resources produce flexibility only under certain circumstances; studies that assess the impact of IS on flexibility may need to incorporate the external conditions. Zhang details the influence of environmental factors. For him, three dimensions of the environment are important.

The first is environmental turbulence: in fast changing environments, different assets and capabilities (resources) are required than those needed in more stable environment. In a turbulent environment, advantages (or the organizational properties such as flexibility) are short-lived as competitive and environmental pressures quickly undermine any resource value. Here, the capabilities are externally oriented placing an emphasis on anticipating market requirements, creating durable customer relationship and understanding competitors. Those firms in more stable environments usually deploy capabilities from inside the firm in response to market requirements and tend to be internally focused (for example, technology development and cost controls).

The second dimension of the environment is the environmental munificence. Environmental munificence refers to the extent to which a business environment can support sustain growth. Rapidly growing markets are typically associated with a high degree of munificence; for them, capabilities externally oriented or which involve internal and external analysis, support organizational goals by monitoring changes in the environment to coordinate internal responses to such changes. Markets that are mature or shrinking are normally characterized by low level of munificence. These markets maximize internal efficiencies; capabilities inside the firm (such as cost effective IS operations, reducing costs and streamlining operations) play a key role.

The last dimension is environmental complexity. It refers to the heterogeneity and range in the industry and organization's activities. This dimension can include, for example, number and types of suppliers, consumers and competitors that the firm interacts with,

the number of inputs and outputs required for the organization's operations or other similar measures. For firms, complexity makes it more difficult to identify critical resources.

The view of flexibility under a resource based approach explained above indicate that resources can be flexible by having certain characteristics; the knowledge skills and capabilities to use them are important too. The view of IS as resources showed that they have a role of support for strategic flexibility; the IS resources form a complex inter-related web of assets pertaining to a single company that are difficult to imitate.

The view of Zhang (2006) is compliant with a contingency approach. In it, a contingency is any variable that moderates the effect of an organizational characteristic on organizational performance including the environment. In here, the term contingency is used to denote a dependence on certain conditions as stated when mentioning that resources linked to flexibility are contingent upon environmental dynamism. The essence of contingency approach is that organizational effectiveness results from fitting characteristics of the organization, such as its structure, to contingencies that reflect the situation of the organization (Donaldson, 2001). According to contingency approach, the organization becomes shaped by the contingencies. That is why the flexibility from a resource point of view is suited to be paired to contingency approach as shown in this work.

2.4.2 Paradox of IT flexibility

IT can provide flexibility to an organization in different ways; it was explained before how IT was related to strategic flexibility. Other examples can be found in new paradigms of IT architecture design that provide the foundation for rapid response to changing market conditions. But Lucas and Olson (1994) found that there is also a paradox. They argue that IT can have an impact on organizational flexibility but the IT

that provides that flexibility can also be inflexible itself. The paradox relates to flexibility at different level, organizational flexibility and technological flexibility.

The detail articulation of the paradox is as follows. For Lucas and Olson (1994) IT refers to hardware, software, procedures, personnel and data employed in the production, dissemination, and utilization of information, both formal and informal in an organization. The key technologies include computers, computer-controlled devices and telecommunications networks. But for them, IT is not only tangible equipment and programs, it also represents the capacity of the firm to produce, disseminate, and digest information. They argue that IT has the potential to alter organizational flexibility, but increased flexibility is not gained by every organization employing technology.

For Lucas and Olson (1994), IT contributes to adaptability and change in several ways. One relates to communications technologies helping remove the constraints of time and place in decision-taking; technology also removes organizational boundaries by enabling the easy asynchronous communication between different locations so that time of day and time zone are not a constraint.

A second contribution of IT to adaptability comes from the fact that the technology speeds the processing of information so that timely decisions can be made. Finally IT contributes to adaptability because tasks can be performed rapidly to take advantage of new opportunities, if there is also speed in information processing, then the possibility to respond to changing market conditions is present. The first conclusion one can find is that organizational flexibility is possible due to IT.

When flexibility is analyzed at the level of the IT itself the landscape is different. Many systems are complex and difficult to modify. Their complexity makes them difficult to adapt and so they are inflexible themselves. The complexity of IT comes from several sources, starting with the interfacing and communicating of devices which involve the existence of several different interfaces and formats that the designers must deal with. IT is inflexible also because major systems include thousands of lines of computer code and making changes to working programs often has unanticipated consequences to

some other place in the program. This complexity reduces the flexibility of specific IT applications.

IT can create an unintended decrease in flexibility in two ways: first by increasing the time, effort, and cost to change systems; and second, by increasing the time, effort, and cost to change workflows and organization structure. The conclusion here is that IT can become inflexible and introduce organizational rigidity. If the fact that organizational flexibility is possible due to IT is combined with the conclusion that IT may be inflexible, then a paradox is formulated.

The flexibility paradox suggests that technology can contribute to organizational flexibility, but IT itself is often considered inflexible, because the technology that provides flexibility soon becomes hard to maintain, and the organization tends to become more inflexible over time. Under this paradox, how can organizations use technology to increase flexibility? From Lucas and Olson's work one can conclude that it is related to resources and its adequate use concurring with previously explained views of other authors. Lucas and Olson (1994) explain that at an operational level, senior management involvement is fundamental in setting the technology strategy and goals. They must also ensure that they have adequate staff and knowledge to implement and maintain technology. For them, the firm must be able to handle the increased complexity that comes from the deployment of more and more information technology and think about how it can contribute to flexibility. Staff and knowledge are resources a firm possesses; the way to use the technology refers to the application of flexible resources. The challenge is to take advantage of IT in a proper manner to increase flexibility and break the paradox. Although the authors explicitly mention IT, the paradox for IS level still holds as IT belongs to the IS level.

2.4.3 IS Flexibility from a development point of view

There are several components involved in flexibility: technology and human components, factors related to the development process, structural characteristics of software. The flexible software structural characteristics include functional decomposition, independence of modules, data separated from process, clear and well documented interfaces and single point of contact or the requirement that an operation used in more than one place should be contained in just one program. These elements were studied by Avison, Powell, Keen, Klein, and Ward (1995) focusing in the development and maintenance of applications. This field has been selected as a topic for IS flexibility because maintenance and development process suffers from many changes during the process and so it needs to be able to adapt.

One of the situations that constitute a source of constant changes in Information Systems is the inaccuracy when defining requirements. Users tend to change what they had defined as their needs at various stages of the development process; at the analysis, the design or any part of the implementation. It is also common to have requirements that are incorrect or badly defined. This causes that the software in development needs to be changed or adapted even though it has not be finished yet.

Avison *et al.* (1995) studied ways to mitigate IS maintenance problems and they found that flexibility can be included in the development methodology or process as well, not only in specific elements of the software or hardware used. Maintenance problems arise because the users change frequently the software requirements; for programmers and developers there is a high degree of uncertainty on when or how these requirements will change. They propose that if the development (or maintenance) process can be flexible then problems related to changes in the IS requirements while being developed can be corrected more easily.

Another way to deal with uncertainty related to requirements changes is to find and identifying possible future requirements; that is, to anticipate what the user may need. In

this way, there are fewer uncertainties to deal with. In their work flexibility is articulated towards in making the development process flexible and also in the topic of designing flexible software so changes can be implemented agile. To incorporate flexibility into the IS development process they define a framework composed of five developing stages, each with a description of the stage and an explanation of how flexibility is related to that stage.

2.4.4 Definitions of IS flexibility

To have a clearer idea of what resources are suitable for IS flexibility it is important to start first by reviewing how IS flexibility has been defined. In doing so, one can find that IS flexibility has been defined ambiguously (Golden and Powell, 2000; Patten, Fjermestad and Whitworth, 2009) and there is not a universal definition. This is due to the nature of the term as shown in Evans (1991) in organizational flexibility. Quoting Schlueter-Langdon (2006), “The IS literature presents a multitude of definitions and conceptualizations of flexibility”.

Nelson and Ghods (1998), Byrd and Turner (2000,2001), and Duncan (1995) have made important contributions to the development of a unified perspective. Nelson and Ghods (1998) as well as Byrd and Turner (2000, 2001) focused on the notion of structural flexibility and developed definitions specifically for IT flexibility.”

When going through management, development and Information System’s literature, to see how IS flexibility was defined, it is common to find IT flexibility referenced, as IS flexibility. IT is a component of IS and mainly authors speak of IS when they only refer to the IT component.

The scholars’ definitions include a variety of ideas; for Nelson and Ghods (1998), IT flexibility is defined in relation to process and structural flexibility where process flexibility is the ability of the technologies technical and management process to accommodate change; structural flexibility is the capability of the design and

organization of a technology to be successfully adapted to business process change. This is a view oriented to organizational aspects.

There are other definitions that include a RBV and speak about components or resources and capabilities involved, a good example of that is the definition from Beimborn, Joachim, Schlosser and Streicher (2009). For Beimborn *et al.* (2009), IT flexibility is defined as flexible technical IT resources, flexible human IT resources and flexible complementary IT resources.

Other definitions are more oriented towards capabilities or specific characteristics of resources that enable flexibility. For example: For Schlueter-Langdon (2006), IS flexibility is defined as the ready capability of an Information System to be adapted to new, different, or changing business requirements. The reasoning behind Schlueter Langdon's (2006) definition is that the ontological aspects of flexibility involves the notion of a resource present and of the adaptation to some event.

For Duncan (1995) IT Flexibility is defined as the ability of a resource to be used for more than one end product. Based on this she defines IT infrastructure flexibility as the degree to which its resources are sharable and reusable.

For Schober and Gebauer (2009), Information System flexibility is defined as the extent to which an IS can be modified and upgraded following its initial implementation. The view of Byrd and Turner (2000, 2001) united the resources that are components and dimensions to arrange them and characteristics of resources. They define IT infrastructure flexibility is the ability to easily and readily diffuse or support a wide variety of hardware, software, communications technologies, data, core applications, skills and competencies, commitments, and values within the technical physical base and the human component of the existing IT infrastructure.

2.4.5 Overlapping

It has been pointed out that the term IT flexibility is ambiguous and complex (Patten *et al.*, 2009) it is often used to refer to some element of IS flexibility or to technology flexibility. Patten *et al.* (2009) explains that for different concepts used to express IS flexibility, there is a different connotation because flexibility resides in different characteristics; i.e. flexible software implies mass customization and flexible IT personnel implies a person able to recognize the opportunity for change.

When there is a reference to an 'Information System' it is not always clear if it implies the use of any kind of technology in the process; but it is usually taken as if it would. The common situation is that when authors refer to IS flexibility it is associated with Information Technology or Infrastructure flexibility. For example, in Duncan (1995) it is mentioned that 'infrastructure flexibility determines the ability of the IS department to respond quickly and cost-effective to systems demands, which evolve with changes in business practices or strategies. The ideal flexible infrastructure would be one that was designed to evolve, itself, with emerging technologies and would support the continuous redesign of business and related IS processes.' This statement was made with the intention to speak about infrastructure flexibility, but it has references to elements (such as the IS department) that are more closely related to Information Systems.

2.4.6 Assessing IS flexibility

Schlueter-Langdon (2000) made a conceptual description of IS architecture capabilities to articulate IS to flexibility. IS capabilities are the fundamental competencies, skills, and tacit knowledge that an organization develops in order to effectively acquire, deploy, and leverage its IT infrastructure in pursuit of its business strategy.

For him, IS is defined as a group of IT components serving a common business automation purpose and IT infrastructure components include computer hardware,

application software and databases, and telecommunication networks as well as human dimension (intellectual assets such as knowledge, skills, and experience).

To put this concepts together he goes into defining IS architecture as the manner in which the components of an Information System are organized and integrate; this includes human IT elements and IT infrastructure. The main point in his work is that there are two capabilities that help in designing IS that create business value: IS flexibility and integration. In researching how IS flexibility as a particular IS capability of the firm contributes to business value, he articulates and defines a construct that is useful for assessing IS flexibility. It is shown in table 2.5.

<i>IS flexibility Construct</i>
The information systems are designed to accommodate changes in business requirements quickly
The manner in which the components of the information systems are organized and integrated allows for rapid changes
The ability of the systems to grow or expand in order to handle new and larger amount of data, users and transactions is high.
The information systems are designed to support new business relationships easily
The information systems are highly scalable

Table 2.5 IS flexibility assessment: an IS capability to create business value. Adapted from Schlueter-Langdon

2.4.7 Components of IT flexibility

To go beyond a broad definition of IS flexibility some authors have studied its construction by looking at the IS dimensions and thus its elements.

This is the approach taken by Duncan (1995), she refers in her work to IT infrastructure but what she is doing is covering components of IS flexibility. Her definition of IS flexibility states that to have a flexible infrastructure means to be able to share and reuse the IS component; after acknowledging that, she uses a RBV to analyze them.

Around these two concepts, she develops what aspects of IT infrastructure components refer to shareability and reusability. In her quest to find those aspects, she goes into IS flexibility components (resources) and management factors (use of resources). She starts by analyzing how IT is constituted and finds that IT architecture is composed of shared tangible IT resources that provide a foundation to enable business applications. These resources include hardware, operating systems, networks and communications, data and processing applications.

The sharable aspect in IT infrastructure refers to reach (defined as the connectivity of IT platforms or number of platforms to which a firm can connect) and range (capacity to share types of IT services). Reusability is related to applications and data (applications and data are considered part of the infrastructure resources). Reusability enables the long-term use of IT by individuals.

Her resource base view of IT infrastructure flexibility also considers issues related to resource management to expand the construct, these refer to infrastructure planning and management factors that include alignment, technology plans and skills of personnel. The specific skills involved are not identified; meaningful skills for flexibility would be, in general, IT skills.

Another topic that falls under management of resources for her, is the establishment of rules and standards. In the sharable and reusable aspect of components, data and applications play an important role as they are embedded in the IT infrastructure; the idea behind this is that data and software can be converted into reusable objects as independent modules.

She identified an operational view of infrastructure flexibility with the usage of these previous proposals, the findings suggested that components of IS flexibility are:

compatibility rules, management leadership, connectivity of systems, and interface standardization.

According to Duncan, an organization with high connectivity, compatibility, and modularity is viewed as a having high technical IT infrastructure flexibility.

Other view of the components of IT flexibility is found in Byrd and Turner (2000,2001). IT infrastructure flexibility construct is the main interest in their work and defined it as the ability to easily and readily diffuse or support a wide variety of hardware, software, communications technologies, data, core applications, skills and competencies, commitments and values within the technical physical base and the human component of the existing IT infrastructure.

For them, unique characteristics of IT infrastructure determine the value of that infrastructure to an organization. One such characteristic is IT infrastructure flexibility. IT infrastructure includes two concepts: technical IT infrastructure components (application, data and technology) and human IT infrastructure components (knowledge and competences to manage effectively IT resources and knowledge and competences of the IT personnel as well).

The technical IT infrastructure is described as part of the organization's information capacity that builds the foundation on which the specific business activities and computer applications are built. Sharing the view of Duncan, the technical IT infrastructure is formed by a set of shared, tangible IT resources forming a foundation for business applications.

The human IT infrastructure includes human and organizational skills, expertise, competencies, knowledge, commitments, values, norms, and organizational structures. The human IT infrastructure factor is the one that determines the effectiveness on the how IT is converted into productive outputs. It does so with the quality of the knowledge, skills, and experience. This means that two firms investing the same amount in IT and with the same management directions will most likely have different organizational results from that IT.

The main object of the authors in this work is to explore the elements in the IT flexibility construct, the method they use to develop it is to first define the domain of the IT infrastructure flexibility construct (which is essentially a definition of the concept) and then operationalize it by developing a measurement instrument.

Finally, after administering the instrument they performed statistical analyses of the data gathered. To explicit the domain, they define IT infrastructure flexibility as the ability to easily and readily diffuse or support a wide variety of hardware, software, communications technologies, data, core applications, skills and competencies, commitments, and values within the technical physical base and the human component of the existing IT infrastructure.

To precise the content of the construct they identify eight dimensions of resources. The first four are elements of the physical base or the technical IT infrastructure:

- 1) IT connectivity (where connectivity is the ability of any technology component to attach to any of the other components inside and outside the organizational environment).
- 2) Application functionality (this relates to the ability to add, modify, and remove the modules of software applications with little or no widespread effect on the applications collectively).
- 3) IT compatibility (where compatibility is the ability to share any type of information across any technology component).
- 4) Data transparency (it is defined as the free retrieval and flow of data between authorized personnel in an organization or between organizations regardless of location).

The remaining four dimensions are elements of the human component or human IT infrastructure:

- 5) Technology management (it pertains to the organization's ability to deploy IT in the most effective possible manner in support of the business strategies).

6) Business knowledge (this knowledge relates to the ability of IT personnel to understand the business processes they are to support and to apply the appropriate technical solution to a given business problem).

7) Management knowledge (this refer to the importance of IT personnel having knowledge to assume roles outside their area of training or original competencies),.

8) Finally technical skills that includes the IT personnel skills to assume roles outside their area of training or original competencies.

Using these dimensions, a content analysis of the IT literature was employed, resulting in a pool of items that were used in the development of the initial instrument in the form of a questionnaire that was applied to senior IT managers in large companies. The hypothesized eight dimensions were legitimized through the use of several statistical tests. These tests helped them to discover that the initial eight dimensions selected to define an IT infrastructure flexibility construct.

In the resulting IT infrastructure flexibility construct only three factors contained in the initial 8 dimensions are important, two for technical infrastructure and one for human infrastructure. These three are labeled integration, modularity, and IT personnel flexibility respectively.

The integration factor suggests that the transparent access into all organizational platforms contributes to the flexibility of the IT infrastructure. This factor merged from IT connectivity and IT compatibility. The authors' explanation is that modern telecommunications technologies can typically support the transmission and distribution of all types of information, including voice, image, and video. Even simple telephone lines support the transmission and distribution of all of these types. Therefore, typically where there are connections, any type of information can be disseminated.

The modularity factor is also a combination of two dimensions, application functionality and database transparency. This is explained by arguing that software applications and data typically work together in a manner that it is not easy to separate one from the other.

The four dimensions of the human infrastructure all loaded on one factor, IT personnel flexibility. This means that all four human infrastructure dimensions can be viewed as a single item. The implication of this is that IT personnel within a firm should be well-rounded, with technology management, business knowledge, management knowledge, and technical skills.

<i>Factor Of the IT flexibility construct</i>	<i>Dimension Where the factor comes from</i>	<i>Operationalization of the dimension</i>
	IT Connectivity	<p>Compared to rivals within our industry, our organization has the foremost in available IT systems and connections</p> <p>Flexible electronic links exist between our organization and external entities (e.g., vendor, customers)</p> <p>The organization has formally addressed the issue of data security with access to a number of protocol</p> <p>All remote, branch, and mobile offices are connected to the central office</p> <p>The organization utilizes open systems network mechanisms to boost connectivity.</p> <p>There are few identifiable communications bottlenecks within the organization</p> <p>The organization utilizes a virtual network or VLAN to connect to end users</p> <p>New locations or acquisitions are quickly assimilated into the IT</p>

Integration		infrastructure
	IT compatibility	<p>Remote, branch, and mobile offices do not have to perform any additional steps or procedures to access data from home or central office</p> <p>End users throughout the organization utilize a common operating system</p> <p>Software applications can be easily transported and used across multiple platforms</p> <p>The organization offers a wide variety of types of information to end users (e.g., multimedia).</p> <p>The user interfaces provide transparent access to all platforms and applications</p> <p>Data received by our organization from electronic links (are easily interpretable</p> <p>The rapidity of IT change (e.g.. revision level, release) in the organization is high</p>
	Application functionality	<p>The applications used in the organization are designed to be reusable</p> <p>Reusable software modules are widely used in new systems development,</p> <p>End users utilize object-oriented tools to create their own applications</p> <p>IT personnel utilize object-oriented technologies to minimize the development time for new applications</p> <p>Legacy systems within the organization restrict the development of new applications.</p> <p>Data processing (e.g., batch job. key entry time, etc.) does NOT restrict normal business operations or functions</p> <p>There is a backlog of IT design work for new applications</p> <p>The organization uses enterprise-wide application software</p>
	Data transparency	<p>The organization utilizes online analytical processing (OLAP)</p> <p>The corporate database is able to communicate through many</p>

Modularity		<p>different protocols</p> <p>Mobile users have ready access to the same data used at desktops</p> <p>A common view of our organization's customer is available to everyone in the organization</p> <p>The organization easily adapts to various vendors' database management systems protocols and standards</p> <p>Data captured in one part of our organization are immediately available to everyone in the organization</p> <p>The IT organization handles variances in corporate data formats and standards</p> <p>Data rules and relations (e.g.. tax regulations) are hard-coded into applications</p>
IT personnel flexibility	<p>Technology management</p> <p>Business knowledge</p> <p>Management of knowledge and technical skills</p>	<p>Our IT personnel are knowledgeable about the key success factors that must go right if our organization is to succeed</p> <p>Our IT provides unique channels to suppliers or customers that are difficult for competitors to replicate</p> <p>Our IT personnel are encouraged to learn new technologies</p> <p>Our IT personnel closely follow the trends in current technologies</p> <p>Very little backlog of work exists for IT personnel</p> <p>Investments in IT are best described as long-term and consistent</p> <p>Our organization often uses IT as a component for an information-based innovation</p> <p>The strategies of the IT group and our organization's strategies are well aligned</p>

Table 2.6 IT flexibility construct adapted from Byrd and Turner (2000)

With these results, the IT infrastructure flexibility construct can be expressed more precisely by means of three factors: two for technical infrastructure and one for human

infrastructure. The two technical related factors are integration and modularity. The human factor is referred to as IT personnel flexibility. Integration is the transparent access into all organizational platforms; this includes connectivity and compatibility. IT personnel flexibility includes skills and competencies at two levels: to manage the technical infrastructure and the characteristics of the IT personnel to contribute to flexibility.

After reviewing works of authors who have defined IS flexibility one can see that they mainly have a deterministic approach. They do not use the idea of flexibility as a polymorphous concept. They do not consider that there are many forms of flexibility and just mention factors in relation to it, in their line of thinking, the more of these factors a system has, the more degree of flexibility. For example, for some IS connectivity can be a major issue, for others data transparency; this means that not all factors may be important in all cases. Their approach does not consider the polymorphic nature of flexibility, based on that, flexibility has to be different according to the context of the Information System. All the reviewed work does not make a clear distinction on what their studies are aimed to: elements to support flexibility or ways to measure it. Both concepts are clarified below to have a better understanding of each.

2.4.8 Flexibility enablers

There is a distinction between flexibility metrics, or the metrics that can be used to evaluate the flexibility of a system and the flexibility enablers which are elements whose presence is related to enabling or providing flexibility.. Flexibility enablers are specific factors that, when present in a certain situation, make the system flexible. Flexibility enablers are the elements or reasons that explain where flexibility come form. The work of Upton (1994,1995,1996) is an example of the study of flexibility enablers as his objective was to research and find the specific characteristics of a manufacturing plant

that support the ability to change, that is, the flexibility enablers. Firms decide to develop or acquire flexibility enablers according to their strategies and needs of facing change. Previous research has shown that it should be done so with little penalty in time, cost or performance.

Measurement is the process of linking of abstract concepts to empirical determinants (Bagozzi *et al.* 1991) Flexibility metrics are aimed at measurement of some form of flexibility. This metrics help to qualify (or measure) if a system is flexible; in other words, if it should be considered as flexible. Flexibility measures can qualify several aspects of flexibility, for example, if the system can be adapted or not, if it is able to change quickly, etc. Once firms have developed strategies and decisions on weather to prepare for some events and seek for flexibility it is the moment to develop, install or acquire the flexibility enablers. Metrics can aid assessing if the system is flexible or not and then decide what is lacking. This is the traditional approach of flexibility which demands that flexibility enablers are defined, discovered and known. An approach that united measures and flexibility enablers or factors is found in Nelson and Ghods (1998). They propose, for technology flexibility, a two dimensions conceptualization of flexibility, where flexibility determinants are discussed. Then, they propose that both dimensions be measured to complete capture technology flexibility.

2.4.9 Contingency approach

The polymorphic nature of IS flexibility demands to have a contingent approach to study it. According to Donaldson (2001), the contingency theory states that the effect of one variable on another depends upon some third variable. This variable is called conditioning variable or contingency factor and acts as a moderator as it moderates the relationship between the other two variables. The contingency theory recognizes as main contingency factors the environment, organizational size and strategy. According to his theory, the contingency factors determine which characteristics produce high

levels of effectiveness in a firm. In this context, the term effectiveness has a broad meaning as it can reflect success or failure of an organization in some measure.

Organizational effectiveness can be defined, more precisely, as the ability to attain goals set by itself, to function well, or it can be related, as in this research, to the achievement of flexibility. This is the reason why some authors have used a contingency approach to study issues surrounding flexibility. For example, Gerwin (1993) argues that the form of flexibility required by a firm is contingent upon its strategic objectives; for Evans (1991) the correct form of flexibility is contingent upon contextual factors or the specific situation present, a point of view shared by Golden and Powell (2000).

For Zhang(2006), the IS resources produce flexibility only under certain circumstances such as external conditions, so IS resources are link to value or strategic flexibility contingent upon market context; this latter work does not specify the IS resources it refers to; he only refers in his work to the IS support for strategic flexibility. It is in this support where the contingent factor selected (the environment in this case) acts as a moderator. It does not specify the elements or specific factors that provide the flexibility.

To summarize the contingency approach, a contingency is any variable that moderates the effect of an organizational characteristic on some measure of organizational performance. This leads to the possibility to argue that, contingencies are variables, such as the environment characteristics and the level of dynamism, that moderate the effect of flexibility enablers on flexibility of the Information System. That is, although some enablers may be present in an Information System, it does not automatically yield a flexible system; it will only do so contingent upon moderators such as the environment. Although some authors have recognized the influence of the environment on flexibility, none, up to the best knowledge of this research, has used this approach to analyze flexibility enablers in the dimensions suitable according to the contingency, that should be present to correspond to a form of flexibility in an Information System to answer the question of how flexibility can be achieved. They have covered partial

aspects of the problem. Flexibility in the IS field should be approached in a holistic view also (Volberda, 1996, 1997, 1998) and thus include the appropriate dimensions, and that paired to a contingent approach that help define the suitable enablers according to contextual factors.

Conclusion

From all this body of research, deemed as relevant to the study of IS flexibility to this research, there are several conclusions that can be derived. Here are some important facts extracted.

1. The need for flexibility comes from internal or external uncertainties, whose realization calls for change with little penalty in cost, time or performance. The need for IS flexibility is limited to changes in the requirements due to strategic adaptation or organizational enhancement; or to changes in technology which bring new possibilities or constraints.
2. Flexibility can be approached by characteristics that support the ability to change easily. For IS there are three main factors that have been found, integration, modularity and IT personnel flexibility.
3. However, the changes that have to be made can be of different nature, i.e. flexibility is a polymorphous concept. The form that is suitable depends on situational factors such as the strategic behavior of the firm towards the market (offensive/defensive) or the moment decided for making the adaptation (before or after the event generation the need for change). For IS, such a contingent approach has been scarcely used.
4. Flexibility was mainly approached through different dimensions because it permits to break the complexity of the term in smaller pieces that can be prioritized, measured or studied separately.

From these conclusions it can be seen that there is a gap in the study of IS flexibility that looks at elements that support flexibility (enablers) but with a clear distinction on the situation or contextual factors that make them relevant to really support or enable flexibility. This implies that: 1) enablers for IS flexibility should be found and 2) it must be considered that their support for flexibility is contingent upon contextual factors because flexibility is polymorphous. To cover this gap, this research proposes to create a conceptual framework of IS flexibility that considers all these facts and findings to guide its study and to be able to understand how IS flexibility can be achieved. The following chapter presents the articulation of such a framework and the research design of this study.

Chapter 3 Research Design

Chapter 3 Research Design

The articulation of a conceptual framework of IS flexibility was part of the research design as it helped to connect the various aspects of the problem of interest: flexible Information Systems.

For that purpose, a thorough and accurate review of previous work on the subject of organizational flexibility and IS flexibility was conducted. This review of relevant literature helped to extract elements that would constitute a sound foundation to guide and structure the study of IS flexibility; it also allowed to have a valid framework. The complete articulation of the framework is explained in a later section.

The next phases in the research design were an exploratory field study and two cases that would constitute a multiple case study.

The exploratory field study was conducted in order to test certain elements of the conceptual framework. In this exploratory study the view of managers closely linked to change decisions and flexibility problems were sought and analyzed because the conceptual framework was developed to study IS flexibility to enable the agile implementation of strategies. It elicited information useful for analysis if concepts portrayed in the framework were correctly understood in practice and sought to establish its relation with actual events of a setting when faced with uncertainties and many changes in strategies. The detail of the study and its findings are explained below.

The review of flexibility literature in chapter 2 provided evidence to conclude that the problem of enabling and IS with flexibility is complex because resources that enable flexibility are different for each IS.

For certain Information Systems, there are some resources whose presence is critical for flexibility, for others, the same set of resources does not enable the system with flexibility. This means that the correct form of flexibility is not the same for every IS.

There is a contingent view in IS flexibility that demands an analysis of factors which must be present, depending on the IS that is being considered. This had not been taken into consideration before, so for this research it was imperative to provide a complete view on IS flexibility that could establish the link between a particular IS and the correct set of enablers that allowed the strategies' implementation. For this reason, the research design included two case studies whose objective was to compare IS with different characteristics and analyze the suitable form of flexibility in each one. Two case studies with IS of different characteristics were conducted to test the *hypothesis* that not all enablers presented or identified in the conceptual framework are necessary for every IS.

The field study in this research is presented in section 3.2.

3.1 A Conceptual Framework

3.1.1 Dimensional conceptualization and Definition of IS flexibility

As mentioned before, the conceptual framework was articulated by using as foundation previous findings extracted from a literature review. But before its articulation could be done, it was a necessary prior step to define, what would be the adopted definition of IS flexibility for this research. It would help round the conceptual basis of the research. The definition was selected as follows.

An Information System is defined as IT components to capture, transmit, store, retrieve, manipulate or display information used in one or more business processes (Alter 1996, 1999). By this definition, it is clear that the view of an Information System is a multiple view construct as it relates to many different elements; this implies that defining IS flexibility is a multidimensional problem that requires that multiple views be included (including several views have been found to be a suitable way of analyzing IS flexibility (Volberda, 1996, 1997, 1998)). The dimensions to define IS flexibility should then match

those of an IS: IT, information, business process, and human component (the latter is implicit in the mention of business processes as they are performed by people).

The definition of IS flexibility of Schlueter-Langdon (2006) (where IS flexibility is defined as the ready capability of an Information System to be adapted to new, different or changing business requirements) recognizes: 1) the need of referring to resources or capabilities (which have been proven to be strongly linked to flexibility) and 2) the fact that flexibility is aimed at responding to change. The problem with this definition is that it fails to mention the several dimensions in an IS. In an attempt to incorporate this fact, this research uses Schlueter-Langdon's (2006) definition to propose and develop a more suitable one for that includes the dimensions mentioned in Alter (1996, 1999). For this research, IS flexibility is defined as the capability of the IT and human resources that collect, process, store, and output information to adapt to changes, so that new business tasks can adequately be performed in a continuous manner.

3.1.2 Articulation of the Conceptual Framework

For the articulation of the conceptual framework the elements relevant for IS flexibility were extracted from literature, then, they were arranged in a suitable coherent structure. The complete explanation is presented following.

As stated before, this research's objective is to study IS flexibility to implement changes, and this implies that firms must know how to deploy flexible IS to adapt them swiftly in order to face new business strategies. To articulate the conceptual framework it is important to understand the origin of those changes and what the implications from an IS flexibility point of view are.

To this aim, the Strategic Alignment Model (Henderson and Venkatraman, 1992,1999) is an important contribution: it states that the main sources of changes faced by an IS are the constant shifts in a firm's strategic orientation. This means that firms constantly change their strategies to face uncertainty and this happens more often when firms

operate in turbulent environments. So, having IS flexibility is important in order to be able to implement those strategies.

Henderson and Venkatraman's, model (1992, 1999) helps to select from all elements in IS flexibility literature which are the ones that should be put in the conceptual framework because they affect the implementation of strategies.

The review of flexibility presented in chapter 2 (flexibility was presented at an organizational and IS level) brought light to the fact that there is a gap in the study of the correct elements that enable flexibility in a certain IS.

The work of Byrd and Turner (2000, 2001) and Duncan (1995) are underpinning of such elements, but they do not take into consideration that flexibility is polymorphous and that the contextual situation must also be addressed. For these authors, there are a list of elements that, when present (regardless of the context, situation or particular problem analyzed), enable an IS with a certain degree of flexibility. This view implies that all elements have similar importance, the more elements present, the more flexibility. But flexibility has a price, so trying to have all elements in an IS can be costly so it is better to consider only those that are really important to have for the particular IS.

A better approach is to consider IS' contextual factors because due to their polymorphous property, not all the elements have the same relevance. There is a particular form of flexibility for each IS. This implies that there is a need to include a contingent approach that helps understand which form of flexibility is adequate, contingent on situational setting or contextual factors.

It is also important to consider a RBV approach because as it was explained in chapter 2 resources are tightly linked to flexibility. RBV can be an appropriate theoretical pillar to study IS flexibility and neither Byrd and Turner (2000, 2001) nor Duncan (1995) include this approach.

There is a gap in the study of flexibility that guide firms in making an IS flexible enough to implement changes of strategies.

To cover this gap, a step in the research was to create a conceptual framework of IS flexibility. A conceptual framework was suitable because “a framework is a brief set of ideas for organizing a thought process about a particular type of thing or situation. Any useful framework helps make sense of the world’s complexity by identifying topics that should be considered and showing how the topics are related.” (Alter 1996,1999)

The conceptual framework should aid the understanding of how IS flexibility can be achieved and identify the correct form of flexibility for a given IS faced with particular circumstances.

The approach followed was utilized to define the conceptual framework thereby constructing it by identifying and arranging in suitable dimensions previously defined elements of IS flexibility in the literature reviewed.

The elements are arranged in suitable dimensions because it is a common approach (Byrd and Turner 200, 2001; Duncan, 1995; Nelson and Ghods, 1998). It consists in examining flexibility by splitting the term into dimensions where the system’s flexibility is typically described in terms of them. By doing this, the term can be split into component parts which can be prioritized, measured, and improved (Upton, 1994,1995,1996).

The strategic alignment model and the resourced-based view were used as theoretical foundations. From the strategic alignment model, one can see that there exists a link between the need to adapt to changes in a firm’s strategic course and IS flexibility. In the context of strategic alignment, the problem consists in the fit between the strategies’ formulation and their implementation (in business and in technology).

Strategies formulation involves the managerial choices and decisions which place the firm in a certain competitive position. But in order to have these decisions produce the desired outcome, certain actions must take place to execute them correctly (in business and in technology). Thus, a strategy formulated should be harmoniously implemented: this is referred to as strategic alignment. The strategic alignment concepts were

portrayed in a model called “The Strategic Alignment Model” by Henderson and Venkatraman (1992, 1999) (Figure 3.1).

Four dimensions exist (referred to domains by the authors) in the strategic alignment model. Two of them are external (at this level the strategies are defined) and two are internal (at this level the strategies are implemented).

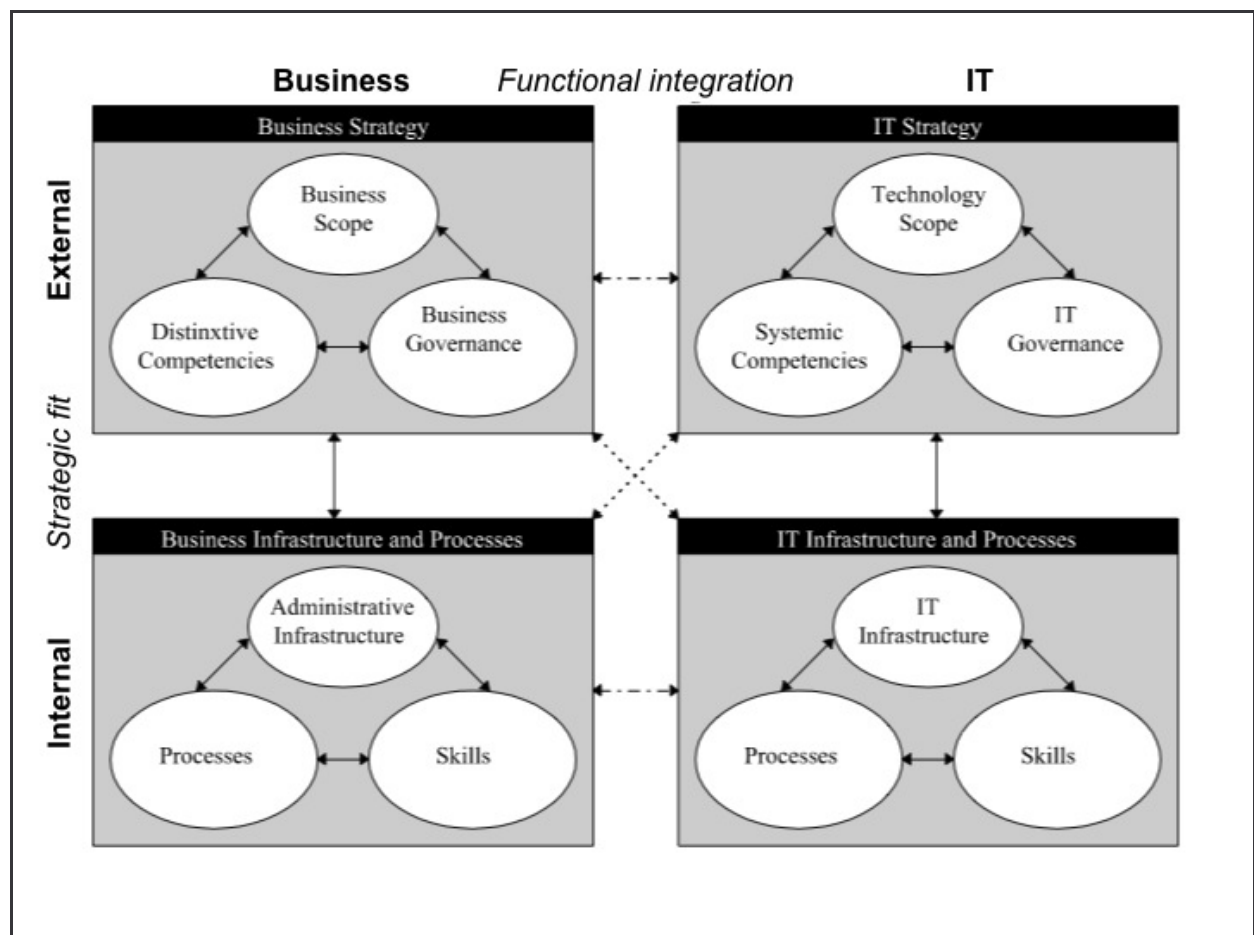


Figure 3.1 Strategic Alignment Model, Source: Henderson and Venkatraman (1992,1999)

The two external domains (labeled Business Strategy and IT Strategy) represent the following:

The business strategy domain represents the strategies defined by the firm's top management (decisions pertaining to the target market, products and services, partnerships and alliances are made); the IT strategy domain represents the IT strategies defined by its management.

The internal domains are labeled "Business Infrastructure and Processes" and "IT Infrastructure and Processes." In these two domains, the actions needed to implement strategies take place. In the business infrastructure and processes domain, decisions on the redesign of business processes (processes), on the acquisition and development of human resources (skills), and on the configuration and management of the administrative infrastructure are taken.

In the IT infrastructure and processes domain, decisions on the redesign of IT processes (processes), on the acquisition and development of human technical resources (skills), and on the configuration and management of the IT infrastructure are taken.

The ideal strategic alignment for a firm is to have functional integration and strategic fit. The functional integration refers to having coherent external levels (business and IT strategies are aligned) and coherent internal levels (business infrastructure and processes are aligned with IT infrastructure and processes).

The strategic fit refers to the coherence of the two business domains (the business strategy domain and the business infrastructure and processes domain) and the two IT domains (IT strategy and IT infrastructure and processes). The two business domains should be coherent: meaning that the strategies defined in the business strategy domain must be harmoniously implemented in the business infrastructure and processes domain. The same rule applies to the IT domains: the IT strategies defined in its strategy domain must be harmoniously implemented in its infrastructure and processes domain.

The strategic fit is the driver behind the need for IS flexibility: when there is a change of strategy, it must be implemented at the business level and the IT level. This means that the Information Systems (that include IT, processes, data, and people) must be flexible enough thereby allowing the strategies' implementation in such a way that alignment or coherence remains.

The need for IS flexibility is then linked to the firm's necessity to be strategically aligned. In environments where there is a turbulence (characterized by dynamic markets), strategies change to face the uncertainty (Sull, 2009), so IS must be flexible in order to stay aligned. Henderson and Venkatraman (1992,1999) point out that strategic alignment is not an isolated state but a process of continuous adaptation and change; this makes IS flexibility a desirable characteristic.

From the strategic alignment model, the construction of an IS conceptual framework can be elaborated for there is a need for the IS to be easily adapted to strategy implementation: IS flexibility (which implies, by definition, the IT's capability and human resources that collect, process, store, and output information to adapt to changes) allows the two internal levels to be able to implement strategies.

As the implementation of strategies takes place in the two internal levels, the definition of the conceptual IS flexibility framework's scope (focused on IS flexibility for implementation purposes) in both the business infrastructure and processes domain and the IT infrastructure and processes domain is established.

Having defined the scope, the next step would be to define the conceptual IS flexibility framework's exact dimensions. The correct approach would be to cover all aspects concerning an IS which are clearly defined by Alter (1996,1999). He describes the precise dimensions that are included in an IS: the IT that makes the Information System possible, the information stored, retrieved, and manipulated in one or more business processes, the latter processes, and the people who participate in them. He goes further in detailing the elements that constitute the IS. He states "business professional

should be thinking about a system that includes a business process, participants, information, and information technology.”

Taking Alter (1996,1999) as the starting point, the IS flexibility framework’s dimensions are defined as: people, process, data,and IT. They will be explained in more detail in the next sections.

The Resourced-Based View (RBV) provides a foundation (as the strategic alignment model does) for the description of the remaining elements that will compose the framework. The Resourced-Based View (RBV) specifies that there are firm specific resources (assets and capabilities) that when used correctly, can take the form of flexibility enablers. This fact can be used to argue that in each of the IS’ dimensions (people, process, data, and IT) one can find these resources linked to flexibility.

Once the conceptual framework’s scope was established, its suitable dimensions defined, and the RBV selected, the next step was to find in the IS flexibility literature the flexibility enablers for each dimension.

A complete and exhaustive review of IS flexibility was conducted to extract resources linked to enabling flexibility in people, processes, IT or data. Once identified, resources that enabled flexibility were arranged in the dimension. The IS flexibility conceptual framework is shown in figure 3.2.

In the IS flexibility conceptual framework, the four main columns (labeled processes, skills, IT, and data) are the dimensions that correspond to an IS. Each dimension is divided in two in order to cover aspects related to strategic alignment. These aspects will be explained below. By utilizing the strategic alignment model to construct the IS flexibility conceptual framework, it includes the changes due to strategy modifications which are enabled by flexibility in the IS level but are in agreement with the strategic alignment model’s foundations.

The next section will describe in more detail the verbalization of the complete framework and the use of the strategic alignment model, the RBV, and the dimensions extracted from Alter (1996,1999).

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business process	Technology
Well documented	Well defined software process	multiskills	Knowledge of the business	Functional Modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical modularity		Location free access
Process decoupling							Data Scalability

Figure 3.2 Conceptual Framework for IS flexibility

3.1.2.1. Process dimension

The Processes column in the framework corresponds to the part of an IS that represents the set of activities in the firm to perform a business task. Alter (1996, 1999) states that a business process consists of steps related in time and place, with inputs and outputs.

In Henderson and Venkatraman’s IT Alignment model (1992, 1999), processes belong to the internal level. In that model, there are two types of processes: the business view and the IT processes. At both levels, there are flexibility enablers that can help implement changes due to strategy modification and so both are included.

The Processes IS dimension in the framework (first column) is divided in two (business and IT) to describe more accurately what resources are linked to enabling flexibility in both the business processes and in the IT processes (figure 3.3). In this way, the framework considers that when changes are implemented, they should be made considering functional integration and alignment. The flexibility enablers for the Process Dimension are explained below.

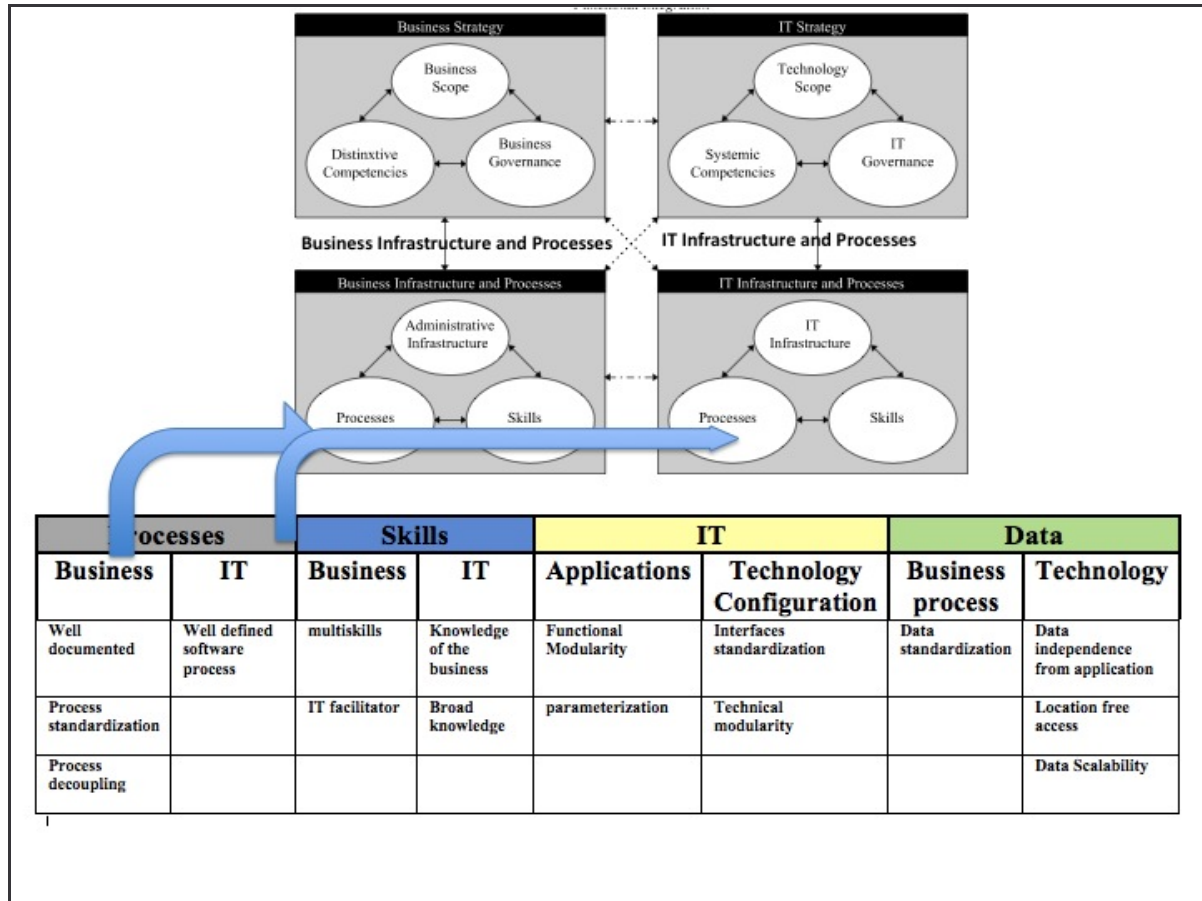


Figure 3.3 Process Dimension and its correspondence with Henderson and Venkatraman's IT Alignment Model (1992,1999)

3.1.2.1.1 Business processes

These processes belong to the business internal level in the Strategic Alignment Model. Business processes, in this level, refer to the articulation of **workflow** for carrying out key activities (Henderson, J., Venkatraman, 1992,1999). From the literature review conducted to extract those resources that were related to enablers of IS flexibility's

enablers , the following were extracted: well-documented, process standardization, and process decoupling.

Well- Documented

A process well-documented is one where there are documents that contain the complete and accurate description of the tasks involved, the sequencing, and the data flows. The documentation of a business process helps to creates clarity about its structure, inputs, outputs, resources, roles, dependencies, and goals, and forms the foundation to analyze, design, and communicate about business processes (Becker, Bergener, Muller and Muller-Weinbergen, 2009). In research conducted, well-understood business processes were identified as success factors in large scale systems projects. Other factors indicate the need for system designers to model processes (Biehl, 2007). Byrd and Turner (2000, 2001) also mention the importance of understanding business processes.

Process Standarization

A standard is something set up and established by an authority as a rule for measure of quantity as defined by the Webster dictionary on line. Standards can be set up by business (in this case they are set at the internal level) or by outside entities such as standardization organizations (i.e. at regulatory or industry level, which would constitute an external level standardization). For processes, standardization means to set up rules on how to perform certain tasks; these rules can apply to processes inside a company but also inside an industry. Process standardization means that the same process is performed in the same manner in every instance where it is executed. It is performed in the same manner inside the company or in the industry, depending on who sets the standard. Process standardization is a flexibility enabler because when there is a need to introduce a change, they are introduced quickly as they are only introduced in one standardized process (Duncan, 1995) (Muenstremann *et al.*, 2009);

that is, if the tasks or the way they are performed need to be changed to adapt to a new situation, this only requires to be established one time. Standardization reduces the complexity of business processes (Bandow, Wenzel and Wischniewski, 2008; Hesser, Vries and Feilzer, 2006) and if they are less complex, they are easier to change.

Process Decoupling

When processes are joint or incorporated together in one larger unit, they are tightly integrated. A tightly integrated process can limit flexibility because a change to one process might affect many others. (Duncan, 1995). Process decoupling is the flexibility enabler that refers to making changes easily to a process when they are not incorporated into a larger unit; in this manner it is easier to find where the change must be performed and also because, if separated, processes can be changed without altering others (Duncan,1995).

3.1.2.1.2 IT processes

These processes refer also to the internal organizational level in the strategic alignment model but the IT view (right side) of it. Henderson and Venkatraman (1992,1999) state that these processes are closely linked to the IT infrastructure's operations, including processes for systems development and maintenance as well as monitoring and controlling systems. Well-defined software processes is a flexibility enabler extracted from literature concerning IS flexibility in this dimension.

Well-defined Software Processes

If development and maintenance processes are well-defined, then the software development maintenance process is controlled and predictable. If the software processes provides control and predictability for software development and

maintenance, then flexible systems are developed (Gebauer and Fei, 2008). Well-defined processes are those whose tasks are clearly detailed.

3.1.2.2 People Dimension-skills

The people dimension in an IS refers to the set of human resources that take part in processes. For an IS, they can be managers and team members involved with the IS' design, development, implementation ,and maintenance as well as the users who belong to the business level. In this framework, the IS' people dimension is labeled as skills for two reasons: the skills are the capabilities or properties in all the people involved in the IS that enable flexibility and also are consistent with the IT Alignment model term. In Henderson and Venkatraman's IT Alignment model (1992, 1999), there are two kinds of skills: those belonging to the people involved in business activities (internal organizational level on the business side of the model) and those belonging to the people working in the information technology activities (internal organizational level on the IT side of the model). These two skills are represented in the framework as the two columns in the Skills dimensions: business and IT. The enablers of flexibility referring to the business and IT people's skills are arranged in those two columns, see figure 3.4.

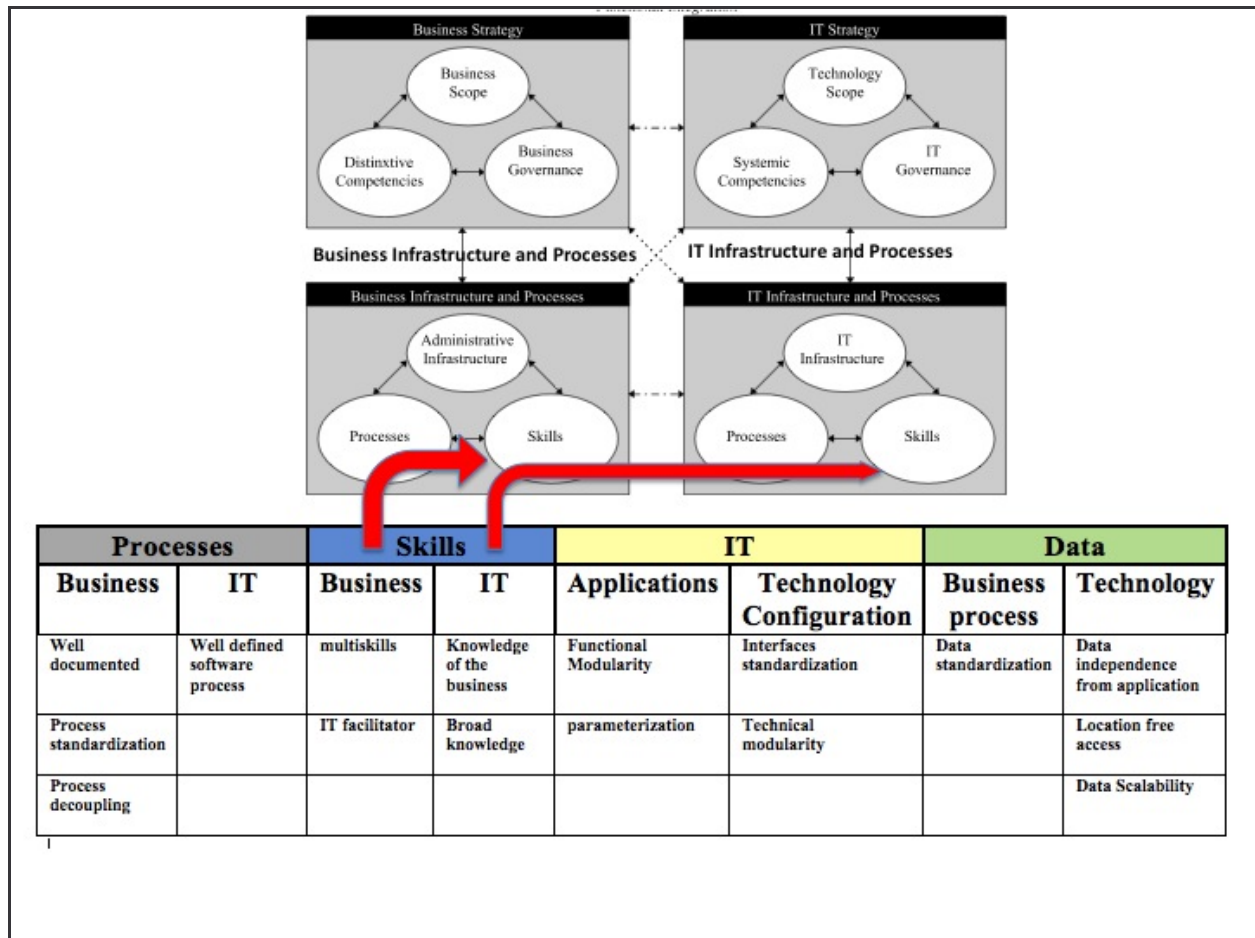


Figure 3.4 Skills Dimension and its correspondence with Henderson and Venkatraman's IT Alignment Model (1992,1999)

3.1.2.2.1 Business skills

The business people's skills are related to the capabilities of the business individuals to execute the key tasks that support a business strategy (Henderson and Venkatraman, 1992,1999). The business skills column refers to those capabilities on the business level that are related to enabling flexibility; Sanchez (1995,1997) refers to the flexibility enablers on the business side as coordination flexibility; it represents the link between

flexible resources and its effective management. From IS flexibility literature, two enablers were extracted, they were labeled as multiskills and IT facilitator. They are explained below.

Multiskills

The term multiskills refers to a person who possesses several skills or abilities. When resources possess a variety of skills, they can perform several tasks and thus be re-assigned to different activities. The multiskills characteristic is a flexibility enabler because when it is necessary to change a person's assigned role, the required skills are easily changeable. According to Volberda (1996,1997,1998), when defining flexibility enablers for a firm, flexibility involves the creation or promotion of several skills, his idea, can be transposed to the IS field too. Multiskills is the same concept as versatility in Evans, (1991) but applied to a person's abilities or skills; in this section, multiskills would be a way to developing a range of skills (or options) before they are needed to be used for different alternatives.

IT Facilitator

IT Facilitators refer to people with technical knowledge that are placed in business units to support businesspeople when technical knowledge is needed. Sanchez (1995,1997) demonstrated that the arrangement of resources is important for flexibility, not only for the resources themselves. The presence of an IT facilitator in a business unit is a particular kind of arrangement of resources to enable flexibility. An IT facilitator is a flexibility enabler as businesspeople can have difficulty adjusting to technology or understanding it (Davis, 1989) and may become slow to respond.

3.1.2.2.2 IT skills

Skills in IT refers to the choices pertaining to the knowledge and capabilities to effectively manage the IT infrastructure within the organization (Henderson and Venkatraman, 1992,1999)

Knowledge of the Business Area

This area is a flexibility enabler mentioned by (Byrd and Turner, 2000). According to them, the knowledge of the business area refers to the IT personnel's knowledge of the business processes and data which they will provide support of. This means that the IT personnel understand the business unit's dynamics where IT is utilized, which means that they understand its business processes and also the data's semantics that flows in these processes. This enables them to react quickly and to find suitable IT solutions for implementing the firm's strategies in an agile manner.

Broad Knowledge

Broad Knowledge refers to the IT personnel's general knowledge of the dynamics of several business units where IT is employed. This knowledge is a flexibility enabler because when IT personnel possess knowledge of several units they can assume IT roles (such as development or deployment of a software package) outside their original area of training (or business unit where they usually develop) (Byrd and Turner, 2000).

3.1.2.3. Information Technology

This dimension refers to the hardware and software that make the IS possible (Alter, 1996,1999). In Henderson and Venkatraman's IT Alignment model (1992, 1999), this dimension represents information technology or architecture at the internal organizational level on the IT side of the model. IT infrastructure refers to the choices

pertaining to applications, data, and technology configuration on that side of the model (Henderson and Venkatraman 1992, 1999). From the alignment model, it can be deduced that at this level flexibility enablers exist in two aspects of IT architecture: in its applications and in its technology configuration. The data level from the IT architecture in the alignment model is excluded in the framework’s IT dimension having been transferred to the Data Dimension. The figure 3.5 shows the IT dimension and its correspondence with the IT Alignment Model.

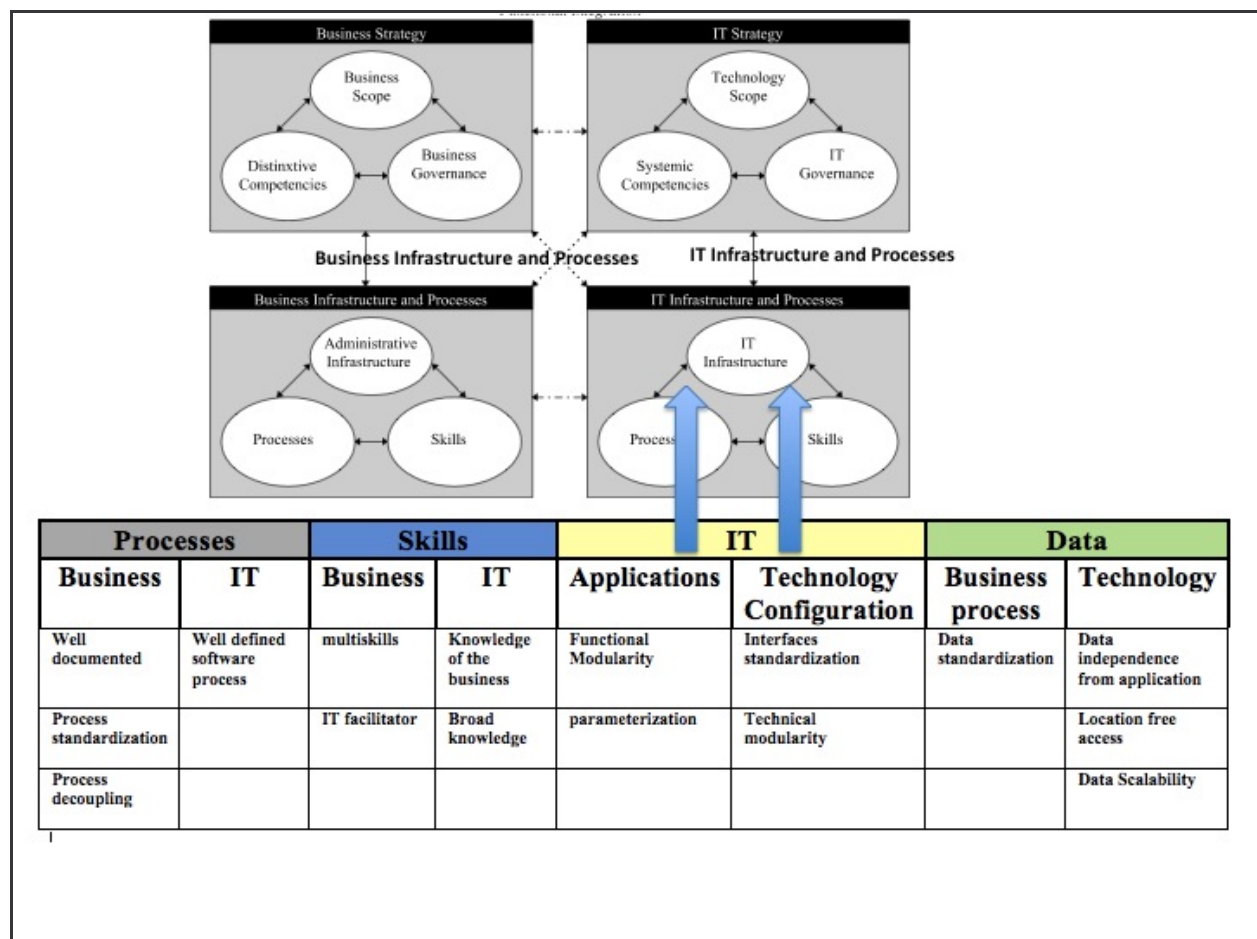


Figure 3.5 IT architecture Dimension and its correspondence with Henderson and Venkatraman’s IT Alignment Model (1992,1999)

3.1.2.3.1 IT - applications

IT applications refer to the flexibility enablers of IS application. The enablers in this dimension are functional modularity and parameterization.

Functional Modularity

Functional Modularity means that the functionality is built into modules that can be easily changed or modified with little or no widespread effect on the rest of the modules in the application (Byrd and Turner, 2000). The concept of modularity for applications has to do with isolating functionality; for the application level, this means to modularize routines (Duncan 1995). This is a flexibility enabler as it enables to implement changes by adding, removing or changing modules as needed as opposed to modifying an application's code which is more time consuming.

Parameterization

Parameterization refers to the application's characteristic to execute a certain function (or software code) depending on a given value that it is specified from the outside. This parameter specifies the boundaries or guidelines for the function's execution. This is related to flexibility because the code can perform several functions without having to alter the code.

3.1.2.3.2 IT- technology configuration

Technology Configuration refers to the technology's arrangement used in the IS. Henderson and Venkatraman (1992,1999) include technology configuration as part of the internal IT level (referred to as IT infrastructure and processes in their model). Changes needed to implement strategies also affect the technology's configuration.

For this reason, two flexibility enablers were extracted from the literature: interfaces standardization and technical modularity.

Interfaces Standardization

Standards are a set of rules or guidelines (knowledge, shared, and adopted by a community) concerning the communication between two modules or programs established for an interface to enable such communication. The interface standardization is oriented towards allowing the interaction and communication of modules or programs. This is a flexibility enabler because it is easy to combine several systems because interfaces are similar in structure. It is a special way of IT connectivity which is the characteristic of components to attach to each other and thus make the flow of information or interoperability agile (Byrd and Turner, 2000).

Technical Modularity

Technical Modularity is the characteristic of technology configuration that allows adding, modifying, and removing any software, hardware or data components of the infrastructure with ease and with no major overall effect. (Byrd and Turner, 2000). It is a flexibility enabler because IT configuration can easily be changed or adapted by removing, changing or adding IT modules.

3.1.2.4 Data

This dimension of an IS refers to the information used in one or more business processes that is captured, transmitted, stored, manipulated or displayed by the IT (Alter, 1996, 1999). Data is found referenced twice in Henderson and Venkatraman's IT Alignment Model (1992, 1999), both in the framework's scope: the internal organizational level. First, data is found in the information flow as the business process is executed (on the business internal organizational level) and second, in the IT

architecture (IT internal organizational level) because hardware and software are used to manipulate it. To represent both views of data in the alignment model, the Data dimension was split in two columns (figure 3.6). Each column represents that there are flexibility enablers in the data used by the business work flows and in the data manipulated by the IT.

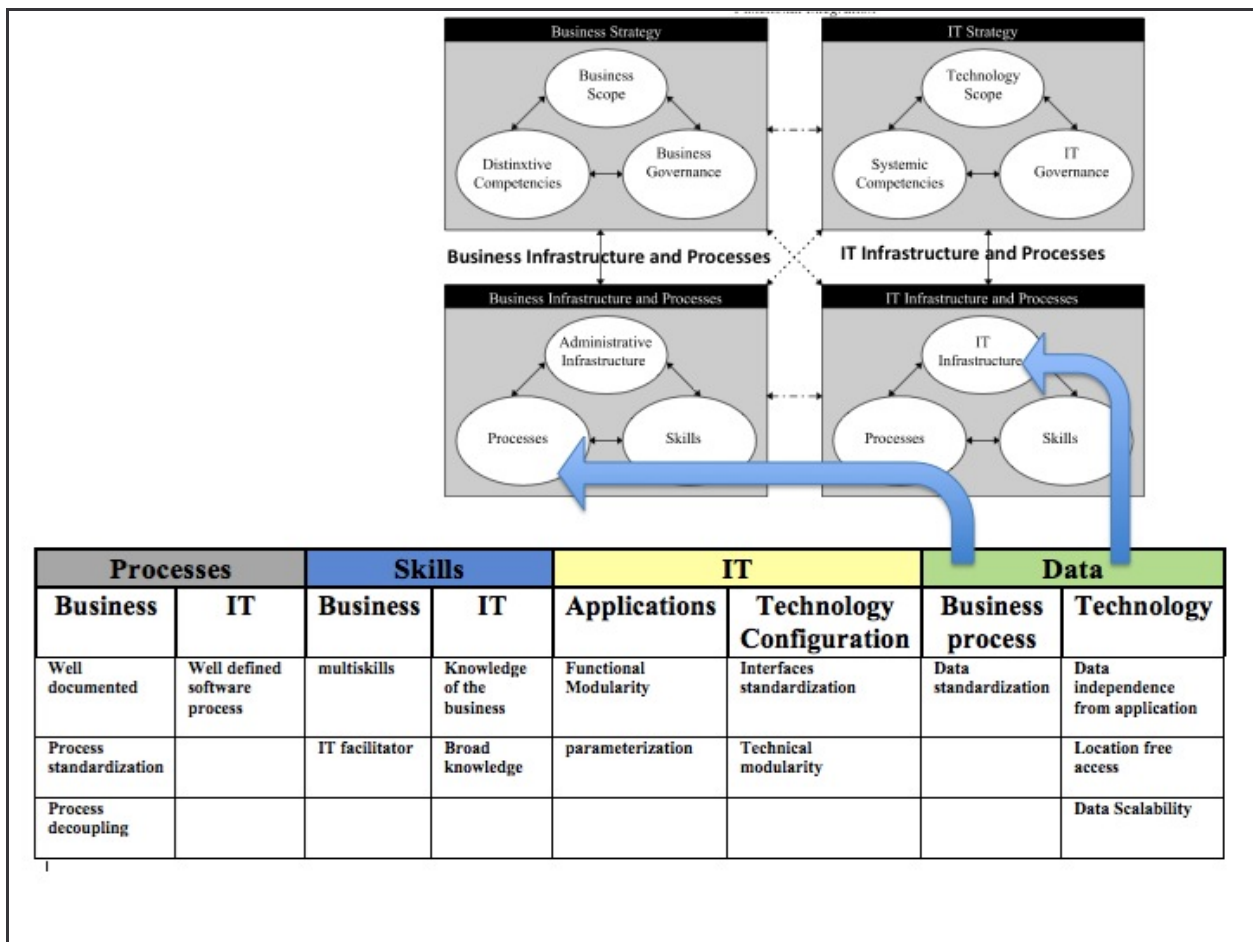


Figure 3.6 Data Dimension and its correspondence with Henderson and Venkatraman's IT Alignment Model (1992,1999)

3.1.2.4.1 Data –business

Data at the business process level is constituted by the associated information flows necessary for carrying out key activities (Henderson and Venkatraman 1992,1999).

Data Standardization

Data Standardization is the definition of business data structure and its semantic meaning that are widely recognized and employed inside a firm or an industry. If data is compatible, that is, if the data has the same semantic meaning and the same format in the company or in the industry, changes can be introduced quickly as they are introduced in a single definition and also because data can be spread out in the company to have it available and respond quickly (Duncan, 1995).

3.1.2.4.2 Data –technology

Data at the technology level refers to the data embedded and manipulated in the IT infrastructure (Henderson and Venkatraman, 1992,1999).

Data Independence from Application

As requirements change data, its rules and access options may be redeployed easily when distinct from specific applications (Duncan, 1995). According to Duncan (1995), “The extent to which data and data management technology do not need to be changed when radical changes in processes or technology or systems occur may reflect the true flexibility of this part of infrastructure.”

Location Free Access

Location Free Access is a characteristic of the data stored in IT that allows it to be accessed transparently or without knowing its location. If the data access is done regardless of the details of its location, it enables flexibility because anyone can use the information to change quickly (Duncan, 1995).

Data Scalability

If the DB capacity where the information is stored can handle larger volumes, thus, it is adaptable to changes that require increasing the amount of data stored without difficulty; for that reason, data scalability is a flexibility enabler (Duncan, 1995).

3.2 Field study

3.2.1 The setting of the field study

The setting of the field study is the telecommunications industry. The telecommunications industry has witnessed many changes since the opening of its markets. Recently, technological convergence has transformed the industry into a turbulent environment because of the so-called triple play of services (consisting of the provision of voice, data and media services on a unique network). Alliances, mergers, and acquisitions have re-shaped the industry. Frantic searches for new sources of revenues and innovative services have added to the uncertainty and turbulence in the telecommunications industry. For example, several wireless telecommunications operators around the globe are spending billions on technology that rapidly transmits large amounts of information via radio signals called WIMAX (Edwards and Ihlwan, 2007);. Several leaders in the telecommunications sector are partnering to provide service to growing markets such as those in South America (Beach, 2007). This industry is representative of a turbulent environment faced to many changes. It is a

suitable setting to capture the circumstances and conditions of the industry where IS flexibility is needed to implement strategies timely.

From the telecommunication industry a mobile telecommunications operator was selected. 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 (Camponovo and Pigneur, 2003). The selection of a single company is intentional, as it isolates external variations that occur within multiple firms. In a single company, all cases are subject to the same culture, values and top management style which make it a better setting for drawing conclusions on other factors observed.

3.2.2 Design of the field study

The field study was conducted through an exploratory field study and two case studies in the telecommunications operator. Both are explained in the next sections.

3.2.2.1 Exploratory field study

Before going into the main part of the field study in the research (the two case studies selected), an exploratory field study was conducted. The main objective was to use data collected through interviews of managers in the company to analyze several issues related to the conceptual framework from a practitioners' point of view. This research phase was designed and conducted to investigate if the issues suggested by the literature and featured in the conceptual framework were actually understood by practitioners as flexibility enablers and to narrow the terms mentioned. The focus was to answer questions such as: what do managers understand as IS flexibility? Do they consider some flexibility enablers important for certain situations but not for others? Can the flexibility enablers extracted from literature be expressed more precisely? Is the conceptual framework accepted in a practical point of view? High level executives and

managers from the telecommunications company acted as participants in order to explore IS flexibility’s indicators. Executives and managers were interviewed because they decide whether to make change initiatives or modify strategy and thus, they are faced with the need to have their strategies implemented in the IS correctly and timely. The persons that were interviewed were three vice-presidents one level below the chief executive officer (CEO), seven executives’ two levels below the CEO, for a total of ten.

The study consisted of semi-structured interviews with open questions about the IS flexibility’s indicators. For this objective, an interview instrument was prepared to obtain the executives’ view on those indicators. The instrument contained a list of open questions related to flexibility factors in each dimension. During the interviews, notes were taken about the interviewee’s comments, and later, comments were added about his job and position. Then, the interviews were transcribed. To elicit and analyze qualitative data, a line by line extraction of the written text, identifying flexibility enablers was done (Burck, 2005). Concepts related to flexibility were elicitedly formed by identifying phrases in the original line by line interview text. “Strauss and Corbin described this as a procedure where the data are broken down into discrete parts, closely examined, compared for similarities and differences, and questions are asked about the phenomena reflected in the data” La Rossa (2005). Table 3.1 shows an example of concepts identified and divided by four dimensions: people, process, information technology, and data.

<i>Concept related to flexibility</i>	<i>Indicator- Phrase mentioned</i>	<i>Original Phrase (Spanish)</i>
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<p>Multiple capacities</p>	<p>The richness comes from different backgrounds of people, different ways of thinking</p> <p>When facing change situations those teams with different backgrounds are the one that adapt more quickly</p> <p>Multiskills people are important. But multiskills in the sense that my people must understand of technology and at the same time they must understand the business, they must understand the user language.</p> <p>A technical profile for people in IT area, but not 100% technical, they must understand the business terms. For example: When speaking of cross-selling they must know what that is</p> <p>Multiskills- people who implement and develop technical solutions must understand of business and technology.</p> <p>To increase flexibility one must run away of specialists</p>	<p>la riqueza viene de diferentes background de la gente, diferentes formas de pensar</p> <p>a la hora que enfrentas situaciones de cambio los equipos de gente con diferentes background son los que con mayor riqueza y rapidez se adaptan</p> <p>Me parecen importantes los equipos multi-skills. Pero multifuncionales en el sentido de que mi gente de aquí entiende de tecnología y debe poder entender de negocios de lo que habla el usuario</p> <p>Un perfil técnico pero no 100% técnico. Tienen que entender comercialmente, como ejemplo que cuando le digan quiero hacer un cross-selling sepa qué es eso</p> <p>Multiskills – Los que implementan soluciones deben de entender de negocios y tecnología</p> <p>Uno debe huir de los especialistas</p>
<p>Process understanding</p>	<p>People must understand the processes because if they skip validations things will not come out right.</p>	<p>La gente debe de entender los procesos pues si se salta validaciones no salen las cosas</p>

	<p>There is a series of procedures that must be followed not "blindly but thinking very well</p>	<p>bien. hay una serie de procesos definidos que se tienen que seguir pero no a tontas y a locas, sino pensado</p>
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Table 3.1 Example of text analysis to identify flexibility concepts in the people dimension

3.2.2.2 Case studies

The conceptual framework articulated in chapter three gives the underpinning and assumptions of what IS flexibility enablers should be considered to achieve IS flexibility. But the complete way of viewing the reality of IS flexibility in the conceptual framework must be based on the concept of contingency on the characteristics that define the type of IS. This leads to the question of: how do we decide which enablers are good for each type of system? To answer the question two case studies closely linked to strategy were selected. The objective was to compare IS with different characteristic to see what the ad-hoc form of flexibility was. In both cases flexibility is very important as strategy implementation is linked to them. But each case has also unique characteristics, i.e. one is more oriented to communication with external entities; the other is used inside the firm. The *hypothesis* considered to apply the concepts and assumptions of the conceptual framework in the both cases is that: *not all flexibility enablers are necessary the same for every IS.*

The multiple case study research strategy method was selected considering the prior inquired questions: *how can IS flexibility be achieved?, How do we decide which enablers are good for each type of system?* The nature of the questions (explanatory) makes the case study method suitable to address the problem of finding their answers. After a design of the framework (conceptual design) it is suitable to use a case study to

evaluate additional conditions (Mora *et al.*, 2008). The multiple case study enables the researcher to focus on understanding the dynamic present (Eisenhardt, 1989). It is a method preferred in examining contemporary events, but when relevant behaviors cannot be manipulated (Yin, 2003). It relies on direct observation of the events being studied and interviews of the persons involved in the events. In this way, the dynamic of how the elements in the IS interact to bring flexibility can be analyzed. The method tries to illuminate a decision or set of decisions: why they were taken, how they were taken, how they were implemented, and with what results (Schramm, 1971) which can help in studying IS flexibility. In this method, the findings can be generalizable to theoretical propositions and not to populations or universes (analytic generalization vs. statistical generalization). Case study research strategy can be conducted in a single case or by analyzing several cases; the multiple case design was deemed better for the present work as the evidence from multiple cases was needed to find which characteristics of the IS would paired correctly with certain flexibility enablers and also because it is often considered that results are more compelling; the overall study is therefore regarded as being more robust (Herriott and Firestone, 1993). Each case study selected followed a holistic approach as each contains a single unit of analysis.

An individual Information System was the unit of analysis and one case describes the resources link to flexibility in a single Information System. The Information System is divided following the format of the four dimensions that constitute an Information System: people, processes, data and information technology.

The selection of the cases was done with the aid of a consultation of expert technology managers with vast knowledge on the technological infrastructure of the company and the problems faced to change it and with a high technical expertise. They were consulted for finding Information Systems that covered several criteria. First, the application (IT) was considered as flexible by the company so the enablers of flexibility could be extracted.

Second, both Information Systems (or case studies) selected are closely linked to strategies; in such systems, flexibility is very important because it is at the operational level where flexibility allows the timely and agile implementation of strategies. The third criteria were to have IS with different characteristics in order to test the hypothesis that not all enablers are the same for all IS (that is, to prove that the relevant flexibility enablers are contingent upon the characteristics of the IS). Hence, the two IS selected are different in nature: one is highly oriented to engage in high communication with external entities and is subject to high standardization by an external body. The other is mainly oriented to solve problems inside the firm; it is not subject to any external standardization. Both cases are described in later sections.

As both cases belong to the same company with a similar structure and organizational design, it was possible to follow a similar procedure to conduct both cases. This included interviewing similar people in hierarchy and job description. This allowed conducting research in an operational mode that helped deal with reliability.

3.3 Data Collection and Analysis

The data was collected through interviews, observations and secondary sources. The primary source was done in the form of interviews with individual respondents, each lasting between one and two hours but a few lasted longer. At the site two types of respondents were interviewed those responsible for the technical issues of the software application (technical level interview) and those in the business unit whose processes are supported by the application (business level interview). Technical level respondents were a mixture of managers and the head of the Information Systems Unit with responsibilities for the whole maintenance of the software application. Business level respondents included the director responsible for the entire business unit and others that report directly or indirectly to him. The interviews were conducted during several day site visit to the firm. They were taped and transcribed, in some cases, they were

translated. During each site visit, observations were made that provided real-time data useful for the case. The interviews were open-ended questions that let them explain how they deal with change, problems faced, factors that turned out to be useful for the faced problems, and the environment surrounding them. The interviews had sections for each of the four dimensions that comprise the Information Systems view. The questions in each section focused more on technical or business details depending on the level of the interviewee. The interviews also included background on the respondent duties and interaction with other units. The following persons were interviewed:

- The IS Unit director.

The Information Systems 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 maintaining systems. Hierarchically, the Director is two levels below the Chief Executive Officer. For each case study the following six persons were also interviewed.

- An IS manager

This person is the technical manager responsible for the team in charge of the maintenance and operation of the IS application. Both interviewees in this position work in the IS unit and are four levels below the CEO.

- Another technical persons in the IS unit

These technical persons are close to the development and maintenance of the application.

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

He is two levels below the CEO

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

The qualitative data related to flexibility were extracted from the transcripts to extract flexibility factors to be compared with those in the framework and see the relation among them under this scenario's characteristics. In addition, it was also gathered secondary data that helped to form an understanding of the forces in the industry, market dynamic and parent firm.

***Chapter 4 Field Study: Results and
Discussion***

Chapter 4 Field Study: Results and Discussion

4.1 Exploratory Field Study

4.1.1 Comments of the field study related to the people

Generally, regarding people and their skills, the answers are heavily skewed toward the need to have a high degree of group interaction and collaboration among the stakeholders in the telecommunications company because of its fast-moving environment. The problem these activities face is that interaction and collaboration, by their very nature, require a high degree of flexibility and malleability in human work systems. This is consistent with the flexibility enablers that relate to having knowledge of the business environment and dynamics because this shared knowledge enables fast and accurate communication. Skills and capabilities were also mentioned in interviews, as a means to achieve IS flexibility. An executive mentioned initiatives being practice towards the achievement of multiple skills. They all seemed to acknowledge that multiple skills is a managerial task, involving the creation or promotion of capabilities for situations of unexpected disturbance. A skill that serves this purpose that was mentioned very often by the managers is the capability to understand. This capability was mentioned as it related to understanding business dynamics, processes, requirements, specifications, and technology. For example, although marketing managers are involved with strategies definition and new products, skills mentioned are not mainly related to marketing skills, but to the capacity to understand the ever changing business dynamics of their market and thus, the ability to define ad-hoc strategies. One executive mentioned the understanding of IT too. But none of them mentioned under which situations skills are necessary, they mainly see the need to have multiple-skilled people all the time. This can be very costly and may not be needed

in every case. An example of this is seen in the development of a requirement definition document. It must be defined carefully, completely, and with much detail. Frequently, several units are involved in the process. The requirements are also constantly fluctuating because of uncertainties in the environment. Therefore, the skills to quickly understand, define, and implement these requirements are critical. Although they acknowledge that business and technical knowledge are important, there was slight evidence of the fact that business and technical knowledge (together as a human resource) are not important all the time. An executive mentioned: “for commercial people, understanding technology makes them flexible; but what worries me, is that they would waste or spend their time trying to become technical because the core of their activities is to develop new offers and services or commercial strategies.”

4.1.2 Comments of the field study related to processes

Executives perceived the issues of process flexibility mainly as steps prior to their implementation, for example, they mentioned complete and correct process definition or the need to have processes defined in such a way to be easily implemented. It is precisely at this definition level that interviewed IT managers believe are the issues of process flexibility. This raises the question if a more managerial view of process flexibility is suitable for IS flexibility. Process definition and their specifications were mentioned as critical for responding to changes on time. The correct definition of the process' specifications was identified as critical and also as a source of flexibility. The development of these specifications is a complex problem (several people involved, who are not always completely or clearly defined by commercial units, not always understood well, etc.). Managers stated that this definition should be clear, easy to implement, and well documented. A constant in these interviews is the importance of understanding processes and communicating them. An executive mentioned, “a clear process can be communicated and understood easier.” Managers perceived that too many tasks associated with a simple activity as a constraint to agility. According to their

experience, the processes that are strongly linked to operations or those that involve several business units should be especially flexible. The argument behind this reasoning is that changes in those processes have more impact on the organization. Well-documented and standardization are flexibility enablers in the framework which can aid in this aspect. Other important issues according to the managers that promoted IS flexibility in the process dimension were enforced alignment of processes with enterprise policies, clearly defining shared processes, and the existence of a governance structure. These factors are all closely linked with standardization and guidelines.

4.1.3 Comments of the field study related to IT

The issues suggested by the responses indicate that problems surrounding IT flexibility are more related to how technology is managed and not so much around technical or architectural details. This may be due to the fact that they have a different perception, in which they are not directly concerned with implementation details in IT. Another managerial issue mentioned by the managers relates to IT planning; it must be done by involving all the right people and completed on time. This planning can sometimes be anticipated, for example, when legislation changes are likely to occur. Having the right people allows different points of view to be heard and to be taken into consideration in IT planning, and subsequently, the IS applications are implemented. Scanning the organization and the environment for knowledge about future developments also enhances IS flexibility since different options can be embedded into the software. The topic of interface management was also discussed by the managers. Such issues as the design and definition of correct interfaces and problems surrounding systems badly integrated where a small change means recompiling many functions were given as examples. When questioned about interfaces, they mentioned the correct definition of them: interfaces easy to maintain, use, and configure. This is a broad managerial point of view but it reflects that their recognition of the fact technology should be able to

connect in an orderly manner. Although executives have a superior point of view of technology, when referring to flexibility, they understand the role of modularity as a concept of “plug-in” new functionality and the fact that systems must be connected, but they do not consider or understand software issues or characteristics or maintenance problems in relation to flexibility. There is a strong influence on flexibility perceived by the user by the fact of having to develop a new functionality vs. just configuring and adjusting parameters.

4.1.4 Comments of the field study related to data

Information gathered from interviews show that the conjoined definition of data (in the sense of data needed and its format) and establishing naming conventions enable managers to act swiftly as they share a common vocabulary and have the data all business units need. Also, they view as important being able to access information in a timely manner to take fast decisions. The managers consider standards with external entities (such as other operators) very important due to the fact of the high level of interaction the industry requires (e.g., to be able to share data from networks of different providers in order to calculate costs and other measurements). On the other hand, they do not consider as important having to enforce standards at the development level in their own IS unit. This can partly be explained by the team arrangement they have (independent teams in charge of a single business unit) and by the high use of external providers to implement applications. It can also be an indication that managers have not acknowledged (or do not know) the fact that enablers are not universal for all systems. As standardization has been mentioned by scholars in relation to flexibility, this can bring into light the need for research with a contingent point of view that helps managers clarify important enablers for certain situations.

4.1.5 Lessons from the exploratory field study

From the exploratory field study several lessons can be obtained that lead to answering the initial questions posed.

On the issue of what managers understand as IS flexibility, we obtained that in general, they understand the concept of IS flexibility as Information Technology that can be easily modified. They do not view an Information System as being composed of several dimensions. But, when asked about individual components of an IS (processes, data, skills and IT) they do acknowledge that these elements can be related to flexibility.

In relation to the question on whether they considered some flexibility enablers important for certain situations but not for others, we can say that Managers understand that there are different elements that can help to make changes easier (i.e. processes that are simple) but they have a general view. In general, they refer to their particular job or position. They do not seem to know that the elements for flexibility are contingent upon the individual circumstances faced, just in a very general way. They mainly have concern for flexibility: in their particular daily activities and at the elements where they have to interact with other business units (i.e. data naming conventions so every one can understand a term and be able to interact easy).

In respect to understanding if the flexibility enablers extracted from literature could be expressed more precisely, it became clear that managers have different knowledge and abilities to understand certain terms expressed by the flexibility enablers. For example, all managers understand general issues of processes and people's skills but not the ones referring to technology. For example, they all understand what is meant by well documented processes or multi-skills but not data independent from applications. So flexibility enablers in literature should be very precisely defined if they are going to be used by a practitioner to make assessments related to flexibility.

The conceptual framework is in general, accepted by the practitioners. Through their interviews it can be concluded that they have problems with implementing strategies

and that these problems relate to the four dimensions expressed in the conceptual framework. They know that there are decisions to be made in order to attain a certain degree of flexibility in their daily activities; they have the idea that there are some elements that bring flexibility but they can not exactly precise which ones are suitable for them considering the four dimensions together.

4.2 Case Study 1: Roaming Information System

4.2.1 Description of the Roaming Information System

The Roaming Information System was a case study conducted. 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 traveling 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 GSMA (a global trade association representing more than 800 of the world's mobile operators, as well as more than 200 companies in the broader mobile ecosystem, including handset makers, software companies, equipment providers, Internet companies, and media and entertainment organizations across 218 territories and countries of the world).

The roaming 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 nature of the roaming services implies high interaction with other telecom operators or carriers. The roaming operations are highly standardized by the GSMA; this makes the interaction easier as they imply the rules and specifications of how to interact.

Information Technology that conforms the roaming application

The Roaming application is the platform to automate the generation of charges incurred by each operator for the roaming services of their clients, which is, rating and charging for the roaming services.

Its main functions 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 send 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 send to the operator.

The application 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 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 too) so it is highly standardized. Its functional architecture is designed to be modular and with clear defined interfaces to introduce new functionality. 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, the software manufacturer also provides the service of human resources for software modifications in need of specialization.

In this company the Roaming System has a degree of independence from other systems. The system's parameters are configured and maintained by the IS Department with the request and configuration documents elaborated by the Roaming Department.

People surrounding the Roaming Information System

Technical people belong to the Information System's department. They are organized in teams assigned to a single business unit. Each team is independent for budget planning and decision taking. The team assigned to the maintenance of the application is called the roaming team and is composed by an IT manager, one project leader, one programmer and three or more specialized external programmers. The requests for changes in the application are done through formal requests defined by the users and sent via the Project Management Office. The roaming team (and all teams in the IS unit) must have good communication with the users (people from the roaming 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. With this in mind, technical and business skills and knowledge are promoted in the teams.

Roaming business unit (Carriers' business unit). It is the organizational unit that uses the roaming application for their operation; this unit includes the human resources, processes and data needed to operate. Its main function is the relationship and business operations with other carriers to provide services. The roaming 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. The roaming manager's job is oriented to negotiate with several entities, mainly other carriers. Her job include the negotiation of terms and conditions of the agreements with external operators and other business units (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 configured the software system.

Processes used by the Information System department. All new changes or maintenance requested by the user must follow certain processes defined at corporate level. They are coordinated by the PMO.

Processes in the carriers unit. Internal processes are documented and standardized (ISO9001 and GSMA) inside the business unit. 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. 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. Relating to data standards, there are no in-house standards de-fined for data. External programmers, 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. The data exchanged with other carriers 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). The diagram of the Roaming case study is presented in figure 3.7.

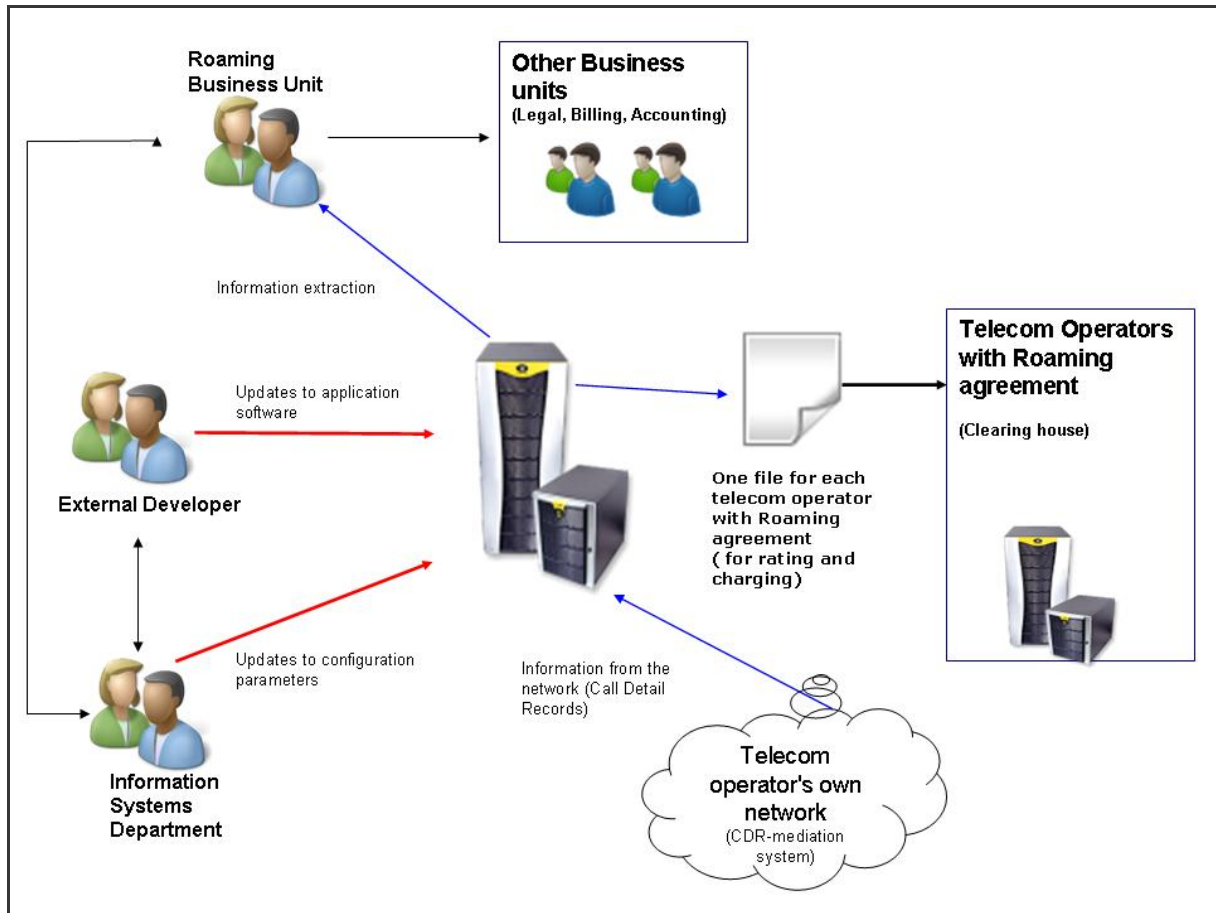


Figure 3.7 Roaming Case Study

Each flexibility enabler portrayed in the conceptual framework was analyzed with the information collected from the Roaming Case Study. The following sections explain the analysis of each enabler in the same order as they appear in the framework.

4.2.2 IS flexibility enablers related to resources in the process dimension

4.2.2.1 Business process

Well documented.

In this case study processes are well documented. The documentation is properly done and stored. The firm is certified in ISO9000 which demands that processes be well documented at the level of the activities performed in each process. The documentation contains the description of activities and the workflow, the owner and responsible (the responsible is the person accountable for the whole process). It also contains details that are required to be included for the ISO9000 compliance, this includes: monitoring indicators or measures of the process and the activities that are performed to monitor it. The documentation is stored in a software application; this application is very complete but complex so it is only used for documenting purposes. For the people in the roaming unit, the documentation is mainly oriented to be a guide so other people involved can understand how an activity is performed, what are the controls established for the process (control understanding is also aimed at verifying if controls are adequate) and also to let people know if a change was introduced in the process. The processes monitoring indicators or measures, allows stakeholders to know which actions must be performed to have good performance through monitoring; in this way, corrections can be introduced to enhance the process as a result of the monitoring activities. At the company level the roaming business unit has a large flow of information with other internal units (i.e. the accounting department or networks operation) this imposes that every time there is a change in a process they must notify it; the documentation serves for this purpose as it is a guide to be used as a reference by all stakeholder. This business unit engages in important interaction with several telecom operators producing a complex interaction dynamic. To break the complexity and understand accurately the operation it is important to understand well the processes; when processes are well

understood (by means of an accurate documentation) the people in the roaming unit can be agile if a change must be introduced.

Process standardization.

The processes in the roaming unit are subject to very strict standardization by the GSMA. The GSMA is an external governance association for the mobile operators; it sets the standards related to all the interaction that takes place between two telecomm operators engaged in a commercial roaming engagement. All members of the GSMA must comply with its standards. The standardization imposed is related to flexibility as it enables the roaming unit to react agile because all interaction (or possible response to an event) is defined previously. When there is a change involved, the actions that must be performed to respond, are defined by the GSMA; this enables flexibility because every one knows which modifications must be included and how; all changes are done equally (and harmoniously) for all operators. It reduces uncertainties on the outcome in case a change is needed, or around an unexpected situation because all operators interacting will respond in the same manner. At the internal level in the company, quality assurance business unit (QAB) sets rules and standards to align the roaming processes to the process model of the enterprise. This standardization enables flexibility because rules and procedures are well defined and interaction for communication purposes among business units is well established.

Process decoupling.

In the roaming business unit, certain processes are link to some processes in the European headquarters because Mexico's subsidiary sometimes uses the commercial roaming agreements of the European headquarters. This helps them to use the European headquarters as a commercial leverage in the roaming services because it is a much bigger company and usually terms and conditions of the agreements are negotiated between two companies but with an implicit dominance of the one who has

more volume of data exchanged or the company with more clients. This implies that some processes are coupled between the two companies; this makes the Mexico's subsidiary slow to respond. If they were independent, they would not have to wait, as they sometimes do. One respondent said in relation to this matter: "the problem is that we are growing and we still don't understand what means to go from an international company to a multinational company". At the internal level in the company they have a large flow of information with other units (i.e. the accounting department, networks operation, etc.); this interaction occurs through flows of information in processes; in general, tasks are independent and not integrated with other units. They have not been faced to difficulties because of the flow of information as it is standardize internally and it does not changes often.

4.2.2.2 IT processes

Well defined software process.

The IT processes analyzed in the roaming case study belong to the technical unit and include those oriented to project management and processes for development, maintenance and acquisition of applications. The Project management office (PMO) manages the projects that are mainly defined to respond to requests for information by the users of IT services. To manage the projects, the PMO has several processes implemented. These processes are well defined but they are long because they have many controls that include the signatures of approval by several people. The effectiveness of the controls is reduced and affected by the bureaucracy included. This bureaucracy can be considered as a bad process definition that restrains from flexibility. On the other hand, each development team of the IT unit is free to define their development and maintenance processes. In particular for the roaming team, these processes are well defined because the development team has adopted the high standardization that surrounds the roaming business unit. This has happened mainly due to the high degree of interaction and cooperation among technical and business

managers. Besides having well defined processes they also have good process documentation that has enabled them with flexibility because the interaction with the outside providers and with the roaming business unit is well defined and known by all the stakeholders.

4.2.3 IS flexibility enablers related to resources in the people dimension

4.2.3.1 Business skills

Multi-skills.

The dynamic of the business unit is very complex and requires that the people involved develop several skills. Specifically, in the roaming business unit the key people (manager and director) have several skills that enable them with flexibility; these include: negotiation skills, understanding the technical aspects of the roaming operation, understanding of legal terms and conditions included in the agreements, and knowledge of some financial rules and calculations. These skills make them independent, as they do not need to be in contact with finance, networks or legal specialists all the time but only at certain activities performed. Multi-skills has been a flexibility enabler as they can respond agile when a change is introduced or a new agreement signed by being independent.

IT facilitator.

In the roaming unit the manager has the role of an IT facilitator; she has certain technical skills that enable her to broadly understand how a business change can be implemented and managed. This technical understanding is needed because sometimes the parameters that define the terms and conditions negotiated in an agreement can change and it is important to know what the impact will be for the application and for the network platform too. The roaming unit saw the need to have people with technical skills to respond better (without the need to consult an IT expert

from the technical unit) and to evaluate a change; for that purpose the manager developed the technical knowledge.

4.2.3.2 IT skills

Knowledge of the business.

The development teams are assigned to a single business unit. This is done with the purpose to transfer business knowledge to the technical people so they can understand better the requirements and make better technical decisions. This knowledge also allows the developers to reduce the ill-define requirements as they can help the user formulate them more accurately and thus reduces the number of changes due to ill-define requirements. Business knowledge enables them to take decisions on whether an application should be developed or maintained (by them or by outside providers) or purchased. In case a provider is involved, they must make the correct decision (based on the needs of the business unit) because a provider can restrain flexibility if it doesn't respond quickly or agile. In the case of the roaming system, the application was purchased. The provider of the application mainly does the maintenance, so for this analysis; they are considered as part of the technical team. They have a high knowledge of the roaming business because they are specialists in the development of software for the telecom industry.

Broad knowledge.

As mentioned in the previous point, the development teams are usually assigned to a single business unit but they can be transferred (or rotated) to a different one. This helps them to learn and understand the operation and the processes of several business units. With this knowledge, they can have a broader view to provide technical integrated solutions in less time; they can also be flexible resources as they can be assigned to different projects (in different units) as needed. The problem identified in

this research with the flexibility enabler of creating broad business knowledge is that the rotation of teams is not schedule or planned as an official and formal policy; and thus it has been a partial policy for a flexibility enabler.

4.2.4 IS flexibility enablers related to resources in the Information Technology dimension

4.2.4.1 Applications

Functional modularity.

The roaming application's architecture is very modular. It was designed to be customized by changing modules and well defined interfaces. This was the criteria for acquiring this application from a third party software provider as the legacy system installed before was difficult to change and restrain them from offering new services. The flexibility enabler of functional modularity is critical for flexibility of the roaming application because it has allowed them to build and complete the infrastructure application to be used as a foundation for providing roaming services in other technologies different from GSM, i.e. CAMEL, GPRS, UMTS or HSDPA

Parameterization.

The roaming application is conceived, since its design, to be able to adapt by adding or replacing modules, by using interfaces to connect and by the configuration of parameters. The architecture of the application is highly parameterized as it was designed to allow the deployment of all signed agreements by configuring the correct parameters defined in it (i.e. inbound and outbound tariffs). This makes very agile the addition or modification of an agreement.

4.2.4.2 Technology configuration

Interfaces standardization.

As mentioned in the previous point, the roaming application is oriented from its design to be able to adapt by adding modules, using interfaces and parameter configuration. The interfaces that are aimed at interaction or communication with the other telecom operators are highly standardized by the GSMA. This enables flexibility as they enable the seamless connectivity quickly.

Technical modularity.

The components in the application's architecture can easily be modified with little alteration to the rest of the software. This enables flexibility to add or remove components needed to physically connect to the networks of other operators. It also enables to connect to other components of their own networks to provide new services (i.e. data and voice roaming services).

4.2.5 2 IS flexibility enablers related to resources in the data dimension

4.2.5.1 Data in business processes

Data standardization.

The retrieval and crossing of information of different business units is difficult because there are no data standards established for the company. At data level, the company allowed each business unit to have their own standards in general; but for the roaming business unit the data standardization is mandatory and established by the GSMA. It is mandatory so that that data can be compatible to enable the exchange of information of the network's usage and calls made between telecom operators. Data standardization is a flexibility enabler because if a change to a piece of information is needed, the

standard is redefined and all the parties engaged in the exchange will know it and adopt it.

4.2.5.2 Data residing in Technology

Data independence from application.

The data is tightly link to applications and platforms in the company in general. This is mainly because it is generated in several sources and different formats; this information is then processed through several applications to be finally stored in structures that are sometimes tightly link to the applications. But this lack of independence is not so important for the roaming case study because the application used has very good interfaces (well defined and easy to customize) that do not change often either.

Location free access.

Data is not retrieved easily in the company for some pieces of information. For example, the DB where the clients' information is stored is not easy to access by the roaming application; this causes that the roaming team must store a copy of it in a DB of their own. This lack of free access implies that the roaming team must also know where information needed is stored and how; but this flexibility factor was not found to be a constraint because of the data standardization and the good interfaces.

Data Scalability.

The data handled for this case comes from the detail of the traffic of calls made in foreign countries. This amount of data is very constant; it increases during vacation periods (because it is at that time when people usually travels) but not significantly. In this case study, the application's DB is not faced to handling larger volumes of

information. Hence, being able to adapt for handling larger volumes of data is not a problem faced.

4.2.6 Lessons from the Roaming Information System

The roaming services imply the commercial relation with several telecom operators that are geographically located apart from each other, with different networks configuration and different business practices and culture. This implies the need to have mechanisms that ensure that the communication and data exchange is done with clear rules followed by every operator. This rules and mechanisms are achieved by the external definition of standards.

1. Processes

They must be very controlled and harmonious among the participant entities. Standardization ensures that the operation among operators is very controlled and performed in exactly the same manner for every operator; it also ensures that processes are less likely to change and thus reduces uncertainty. For the internal level where there are many flows of information among several business units and the roaming, it is important that all processes continue their operation smoothly when changes are performed. When there is a change it is important that every one knows what was the changed performed and how it impacts other entities, flexibility enablers oriented to this objective are very important such as a good documentation. The flexibility enabler found as relevant for this case are: processes well documented and standardize.

Processes well documented act as a control when a change is performed because the documentation can be used to evaluate what part of the process will be affected, who is the responsible and accountable, what other entities are involved, etc. It enables to take

informed decisions on processes modification agile. It also serves as a repository of information to understand the unit's dynamic.

2. Skills

The personnel in the unit must possess knowledge on the business dynamic of the roaming services; they must understand the main actors involved and also the issues related to negotiating and signing an agreement to be capable of taking agile decisions with these information. If the personnel possess multiple skills, they can react quickly and when faced to an uncertain situation or unexpected change because they can respond agile without the need to consult other people.

For this case the presence of an IT expert (or IT negotiator) in the business unit was very important as the application plays a central role and also because the nature of the business is technology intensive; that is, the roaming services are provided by the usage of complex IT inside and outside the company. It is necessary, for this case study, that the people in the business side can have the support of a person who has technical understanding to make agile decisions on how to implement a contract, how to change some terms and conditions, how to deal with a telecom operator with a particular problem related to technology, etc.

The IT department needs also to understand the business dynamic when it is complex (as in this case) in order to decide when a technical change is needed and how it is implemented better.

3. IT

When there is a need to change some part of the roaming application such as the addition of new roaming services (i.e. data roaming services or new ones now possible due to technological convergence) the important flexibility enablers are functional modularity and parameterization. They enable the application with mechanisms to easily

modify the application without changing many parts of the code. In the technological configuration aspects, interface standardization and technical modularity are also important enablers to add-up new functionality seamless to the operation.

4. Data

Data standards have an important role for this case study; it is what enables them to exchange information among telecom operators agile. The standards used in this case study are imposed by an external entity; compliance with them is mandatory. This external standardization could be seen as an inhibitor for flexibility because it is not optional and thus they are not free to define how data should be managed. The information gathered from this case study helped to see that data standardization is indeed a flexibility enabler in certain situations (i.e. in systems where there is a high external interaction). Table 4.1 shows the enablers relevant for the roaming case study in the conceptual framework.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business	Technology
Well documented	Well defined software process	Multiskills	Knowledge of the business	Functional modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical Modularity		Location free Access
Process decoupling							Data Scalability

Table 4.1 Flexibility enablers in the Roaming Case Study.

4.3 Case Study 2: Data Warehouse Information System

4.3.1 Description of the Data Warehouse Information System

The Data Warehouse Information System was the second case study conducted. In this Information System the Intelligence Business Unit has a central role. It unit must provide marketing and other stakeholders with information on the operation of the firm that helps them in their decision taking about products and services (to take commercial decisions and to monitor commercial strategies and new services). For that, they are supported by an application that enables to extract firm's information, called Data Warehouse. The commercial offerings in this firm have become very sophisticated and thus, the information required to monitor them is more complex too adding complexity to the problem of providing it. It is also a competitive growing market, which implies more pressure from all business units to the BIU for providing detail and accurate information to aid them in decision taking. All of the above impacts the time frame to have the correct information available which is shorter every time.

The DWH is subject to different changes. Changes in this IS are mainly oriented at including more detail in the information stored in the DW. This detail comes from adding items that are in the DB with the information generated by the operation of BU (sources) but not in the DW. These changes involve that more information already produced by the firm is included in the DW. When changes happen, as the information is required by financial auditing bodies and must be very reliable and accurate, they hire an external entity who certifies (an auditing external certified firm) that even with many changes; the information delivered by the DW is trust-worthy.

They also certify that the information in the DW is consistent with that of the DB sources. Business rules change but not too often. Business rules changes are especially important as they define how to extract the information. The BIU monitors the changes in the business rules as they evolve or change. When there is any change it

goes into revision by the regional committee (who have a session every 3 weeks) so changes are reviewed. Other changes are oriented to use a copy of the IS in other country of the Latin-American region. For this purpose, the application in each country must be customized. I.e. in Spain they have more customers in post-paid plans, in Mexico more customers in pre-paid plans and Guatemala needed special rules due to political reasons.

Information Technology that conforms the Data warehouse

The DWH is an application oriented to electronically store data generated by the daily operation of a telecommunications operator (i.e. number of calls, destination, minutes, details of clients, etc). When data is generated it is stored in multiple databases (called here operating database), each one belonging to a different business unit in the company; from them, selected information is extracted to be downloaded to the DWH. The main objective of the DWH is to store data in a single container to facilitate consolidated reporting and analysis of information. An external company developed it with previous knowledge on developing DWH applications in the telecom industry.

It was also designed to be used in several countries where the company has operations. The complete set of Information Technology tools that conform the DWH system include technology to retrieve, extract and load the data. To extract, transform and load data from the operating databases, several external providers were contracted to develop applications that served as interfaces.

These applications produce text files that are downloaded everyday into the DWH. As it is a very high volume of data downloaded to the DWH (15 teras daily), it only stores the information of the last 90 days of operation. After that, it is transfer to other storage media. To retrieve the information, some users have a self-extracting tool in their computers; others request the information in the form of reports or small databases. The DWH is subject to constant changes: changes to the interfaces (changes to the

operating databases or addition of information), to the business rules, addition of new business rules, changes in regulations or addition of new pieces of information.

People surrounding the Data warehouse

Information Systems Department. It is the technical unit in the company whose main function is to build, maintain and design the technology to support the operation; these exclude the network platforms to deliver the services. Related to the DWH, they are responsible for the modification to DWH parameters configuration parameters. They do not modify programming code in the DWH at all. Other activities they perform include the development of complex reports and projects to create small databases. The people assigned to the DWH from this unit are organized in a team.

Developer of the DWH (External). It is the company hired to develop the DWH application. This company has prior knowledge in constructing this kind of software for the same industry. Once the DWH was re-leased for operation, they were hired for maintenance in an annual contract mode which includes certain number of changes per month. They are the only ones who can actually perform software alterations to the DWH application.

Business Intelligence Unit. The Business Intelligence Unit (BIU) manages all issues related to the DWH. Among the issues are functions related to the distribution, access, business rules and terms for extracting information in the company as well as the information itself. Business rules and terms (or naming conventions) are tightly linked to the DWH because they define what each piece of information stored in the DWH stands for and how it must be extracted. Terms and naming conventions had to be unified and standardize by the BIU in the company as the information comes from several sources (or operating databases) and distributed to different units whose terms may not agree. BIU sets the standardization on business rules also. For the distribution and access to the information residing in the DWH, the BIU functions as a single-point of contact with

all users in the company requiring information. There are several ways to deliver the information: by installing a self extracting tool in the user's computer, by delivering reports developed by them or by requesting the reports the Information System's data warehouse team. The latest option is selected when the reports are more complex or there is a need information from other sources. The BIU's role of single-point of contact enables them to be a translator between business and technical terms with the Information Systems department and all users in the company. It also allows them to manage all requests (coming from all business units) more efficiently as they are the only entity receiving requests. Through the analysis of all requirements posted, they can participate in strategic decisions surrounding the DW. These decisions include adding in-formation, changing the hardware platforms, acquiring more software licenses (self-extracting tool). The role of the BIU also include the production of reports based on the operation of the company for management control and decision taking (i.e. how many clients they have, what the client consumption is or how much time clients have used the phone in a period,)

Users. All people in the company that needs information residing in the DWH may have access to it. This information can be delivered through a report or with the aid of a self extracting tool installed in their computers. If the client tool is installed, a profile is configured for that person to define the information access grants and permissions.

Users' committee. There is a committee form by a representative from Spain (the company's country of origin), a representative from each country in Central America where the DWH is (or will be) used, a representative from the BIU, a representative from the In-formation Systems Department and users' representatives. Major decisions surrounding the DWH are taken here (i.e. change of hardware or processes); they also set the rules on how to access the DW and on how to manage licenses, they also review technical problems (i.e.: server capacity). It is a Governance entity

Processes surrounding the Data warehouse

Processes are mainly oriented to the user: how to extract information, how to request installation of a license for self extracting tool, how to request for training, etc. They were defined in this committee in conjunction with the company developer of the DWH and the Quality Assurance unit (QA) based on previously existent processes in the countries involved.

Data in the Data warehouse

As explained previously, the information comes from operating databases generated (and owned) by operating business units in the company. These operating databases store a vast amount of pieces of information in several different formats (i.e. subscriptions, usage, client's information, detail of calls, etc.). Due to capacity constraints and processing resources, from each operating database only certain items were selected to be downloaded in the DWH through a file. Each file constituted an interface to the DWH. External providers developed these interfaces. The operating unit who owns the operating database selected each provider.

The diagram of the Data Warehouse case study is presented in figure 3.8.

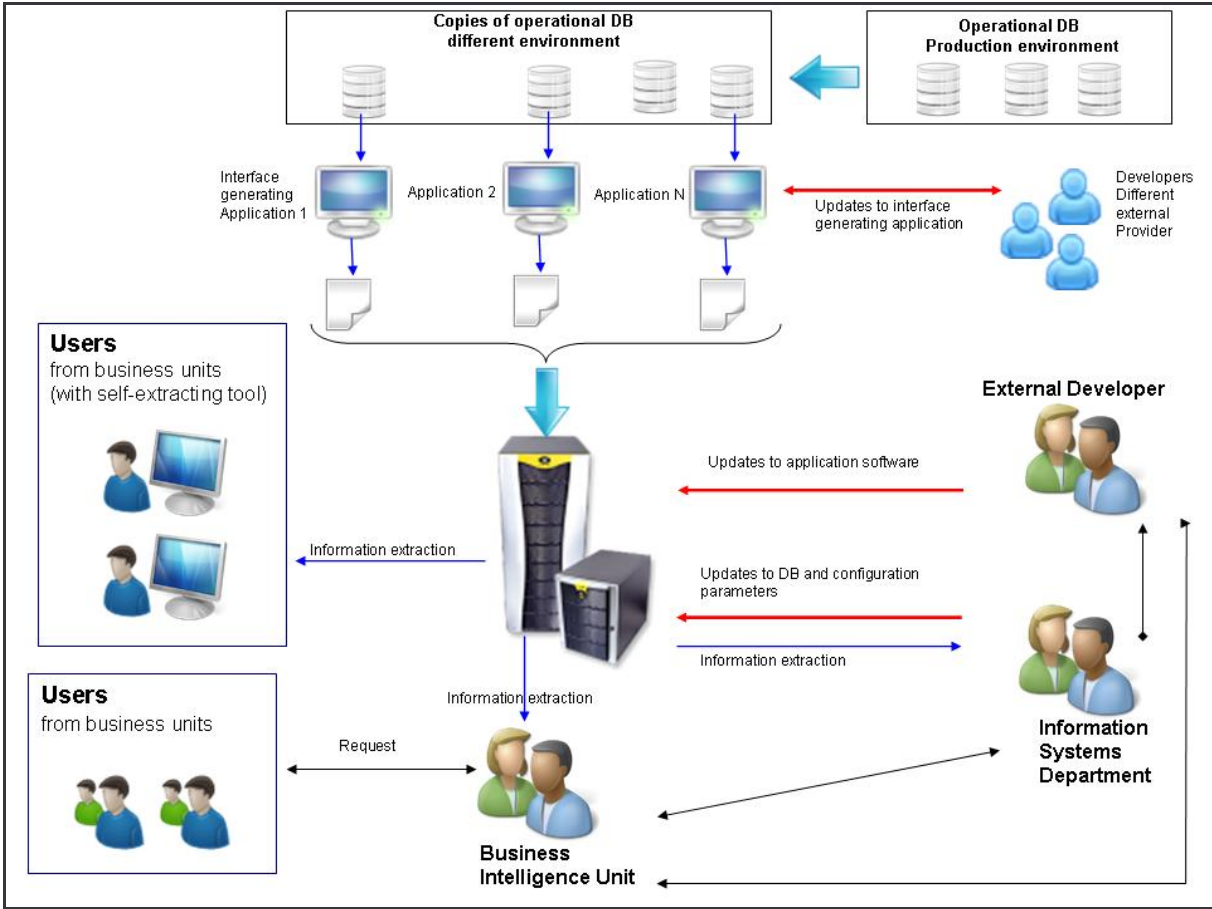


Figure 3.8 Data warehouse

4.3.2 IS flexibility enablers related to resources in the process dimension

4.3.2.1 Business Process

Well documented.

There are two kinds of processes in the Intelligence Business Unit (IBU): ones aimed at the management of requests for information (i.e. when a user requests to have a certain report, or the installation of the self-extracting tool in his computer, or help in training to use the tool, etc.) and others at the down load of information into the DWH (these include all the activities to be performed by each unit to load the interface files with their information). Few of these processes to request for information are completely defined or documented, only the main ones which are defined and documented very broadly. The process documentation, when available, is not stored in a DB. This unit is not subject to any compliance with external standards or auditing requirements in their processes; this means that are not obliged to have a full description and documentation. The processes for the download of information into the DWH are those where there is an interaction with other units; these are clearly and well defined but they are not subject to frequent (or unexpected) changes.

Process standardization.

The processes to request (and deliver information) to the IBU are very general and simple but they are not all standardize. The IBU receives the requests for information and manages those requests with no strict process standardization, they are performed with variations in the activities; i.e. some times the information is delivered by the IBU other by the ISD and they may following different steps to deliver it. This factor has not restrained them from being able to respond to changes as they have the complete operation of the DWH inside a single unit that acts as a single point of contact with the users and IS department. So the lack business standardization, in this case study, has enabled them with flexibility to handle different kinds of requests as they are very different a vary very much.

Process decoupling.

The activities in the processes for extracting information are independent from other performed in the business unit although they are related. AS the IBU acts as a single point of contact and perform all its operations inside the unit, their processes can be very isolated. This has enabled them with flexibility, as they are free to change processes without affecting others.

4.3.2.2 IT processes

Well defined software process.

The processes in the technical unit include the processes of the PMO which are aimed at handling projects defined for satisfying the user's request and also the processes or activities performed inside the DWH development team for the maintenance of the DWH. IT processes analyzed in the DWH case study, do not include the maintenance of the applications to extract and load the files to include information into the DWH; these belong and are the responsibility of other business units. As in the roaming case, the project management office (PMO) manages the projects to respond to the requests for information by the users of IT services; their processes are well defined but too long because they include many activities oriented to control the projects. The activities or processes of the development team for the maintenance or retrieval of information are not well defined, they are free to perform the activities according to the request so they handle each request with slight variations. The development processes not being well defined has not restrained them from flexibility because requests vary very much and also because they are very simple.

4.3.3 IS flexibility enablers related to resources in the peoples' skills dimension

4.3.3.1 Business skills

Multi-skills.

The IBU team is mainly conformed of personnel with accounting and financial background but they have developed skills and knowledge from the business units that are the sources of data. These multiskills has enabled them to understand the meaning and data semantic, how it is produced by the daily operation (frequency, format) and the relation with other pieces of information to manage correctly and quickly the requests of information from the users.

IT facilitator.

In the IBU the manager of the DWH has technical background; her previous job assignment was in the same company in the IS department as a manager of a development and maintenance team. She has a role of an IT facilitator specifically recruited for that purpose. Her presence in the IBU enables it with flexibility as it is mandatory for them to know technical information about the data such as format, semantic, the technology information surrounding the applications where it is stored, etc. to make fast and accurate decisions. As she used to work in the ISD she has knowledge of the issues surrounding several DB (technology implementation, software product, connections, etc.) used to extract the information to be downloaded into the DWH.

4.3.3.2 IT skills

Knowledge of the business.

A development teams is assigned only to the IBU. Their job is to extract information to make simple reports with information already in the DWH and also information in other DB. These DBs store the information of a business unit, so they need to have some basic knowledge of what is stored and how. As there are several DBs (each one storing very different information of different business units) the DWH team is not specialist in the dynamics of a single business unit, instead, they possess a certain knowledge on the company as a whole. This knowledge is very important as they have many different requests for reports that involve knowing the semantics of the data, the rules to extract it and the location. If they did not have a general knowledge they would be very slow to respond to changes.

Broad knowledge.

The people in the roaming team have broad and general knowledge of the DB and applications used in the company. They also have basic technical skills to generate reports; they do not need specialized technical skills to develop reports or small data marts. This knowledge of the company enables the members of the development team to be re-assigned to other projects in different business units which makes them flexible resources.

The DWH application was developed by an external provider who is also hired in a regular basis to perform small software alterations. The technical knowledge of this provider is very specialized in the programming tools used and also in the DWH issues. They are also very familiar with the business dynamic (related to data) of this company. All this knowledge enables them to respond quickly to software changes.

4.3.4 IS flexibility enablers related to resources in the Information Technology dimension

4.3.4.1 Applications

Functional modularity.

The application was originally designed to be modular; it was built to be used by several countries where this company has subsidiaries. The external company that developed it is highly oriented on the use of modular techniques and software re-use paradigm; these facts were considered important as criteria to select them because it was defined as a business strategy to use the same DWH application in several countries.

Parameterization.

The DWH application was designed to be customized for different countries. It was built with technical characteristics to be reused and adapted; parameterization of the application was among the design issues selected to reach this objective: several parameters are changed depending on the country where it is used, in this way it can be customized.

4.3.4.2 Technology configuration

Interfaces standardization.

The information is downloaded into the DWH by defining a set of files that must be loaded with the information from the DBs where the data is originally stored. These files act as interfaces between the DWH and the DBs and are used to extract the information. The interface or set of files are standardized so the loading process can be the same regardless of the source of information. This standardization is very important because the source DBs are very different (they store different data, in different format

and with different meaning) so it enables them to add data very easily regardless of the source.

Technical modularity.

The components in the infrastructure around the DWH can be added, modified or removed because the components are isolated and only connected through interfaces. They do not interoperate or share code in anyway. This is a flexibility factor for the DWH as they need to be able to add new information from several systems.

4.3.5 2 IS flexibility enablers related to resources in the data dimension

4.3.5.1 Data used in business processes

Data standardization.

There are no data standards established for the company so the free retrieval of information and the data exchange in the firm is difficult. The structure of the company permitted that each business unit had their own standards for information. The lack of standardization represented a challenge for the DWH because information from several sources had to be stored in it; for that purpose the key aspect was to unify the semantic of pieces of information that represented the same concept (i.e. the term “client” was not the same in all business units, for some it was a person with a contract, for others it was a person who had requested some pricing information). To cope with that lack of flexibility (due to lack of standardization and naming conventions) the set files acting as interfaces had to be defined. Data standardization is an important flexibility enabler for this case study as it would enabled them to respond more quickly.

4.3.5.2 Data residing in technology

Data independence from application.

Once the data is stored in the DWH, it is independent from its original DB. Its design considered that independence and also the fact that the same software would be used by different countries. To reach both objectives two main factors were decided: to have a well defined interface for downloading information and a common independent data model. The data being independent from the applications is a very important flexibility enabler in this case study.

Location free access.

The data is not easily accessed in the company (because the data produced by the daily operation of the company is stored in several DB dissimilar from each other), in order to make the data retrieval easier and without knowing its location the datawarehouse is populated with critical selected information. There are two main ways to access the information by a final user: with a client self extracting tool installed in their computers and by requesting a report (this can be printed or in electronic media). Both access methods enable the location free access although they have some disadvantages: reports requested can take long to be completed and the self extracting tool is not easy to use. It is difficult to self extract information because the user must have certain knowledge on the information stored (such as its semantic meaning, source, etc.), and rules on how to extract and filter it. There is also a risk of getting confused with the information stored due to the vast amount of information available in the DWH. There is a risk of getting incorrect information if the extracting process and rules are incorrectly applied. For the users, too much information stored makes harder to find what is needed and requires more knowledge to extract. Data access and retrieval can also be time-consuming if the query is complex.

Data Scalability.

DB's capacity is one of the main concerns in this case study as it is a fundamental issue for any data warehouse. The main problem faced in this case study, is not on the technical aspect, but around financial issues (negotiations to have budget and financial resources are complex and difficult). Technically, adding capacity was a design concern since the beginning: it is easy to do. Besides being easy to scale the amount of data, DB's capacity was planned to be enough (considering a significant grow in the number of clients) so they would not even reach 85% of its usage. Data scalability, for the DWH, is an important flexibility enabler.

4.3.6 Lessons from the Data Warehouse Information System

The DWH is an application deployed to serve the needs of information in the firm. It is oriented to store information about the operation of the company. From it, several complex reports can be generated; these reports are then used to take strategic decisions. The main flexibility enablers from the conceptual framework found in this case study are shown in table 4.2.

1. Processes

A relevant flexibility enabler from this case study is that their processes are decoupled. The fact that their processes are independent from other unit enables them to perform activities with variations (without affecting other units), depending on the specific situation faced. This is important because they are faced to many uncertainties as the requests for information are complex, different and must be performed in very short time. The lack of process standardization also helps to be free when performing activities and due to the fact of process decoupling, it does not affect other units. Process standardization is not needed, as they are very independent from other units; if

they were standardized, it would constraint them from varying the way they perform their activities because they would have to comply.

2. Skills

Understanding and knowing clearly the information stored in the DWH is vital for the IBU. This understanding comes from grasping the dynamic of other units because they are the ones that generate and own the information. The people have developed skills needed to be able to understand how to extract and combine very different pieces of information (i.e. financial and operative indicators). The multiskills of the people in the DWH enables them understand clearly the issues surrounding the company's information. As the information comes from several different (and complex) applications, the presence of an IT facilitator is very important to be able to develop good solutions for extracting data.

3. IT

The DWH must be flexible enough to let new pieces of information be stored; this is possible due to the application's characteristics of being modular and parameterized. As the information is downloaded from different sources, it is a suitable flexibility enabler to have the interfaces to do it standardized.

4. Data

The DWH is a system oriented to store, retrieve and cross information to produce complex reports; to make this task easy and in time, all the flexibility enablers of the data dimension should be present.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business	Technology
Well documented	Well defined software process	Multiskills	Knowledge of the business	Functional modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical Modularity		Location free Access
Process decoupling							Data Scalability

Table 4.2 Flexibility enablers extracted from the DWH case study

4.4 Discussion

The results show that the two case studies do not have the same enablers from the framework sustaining their flexibility; and they also do not have the same characteristics; these two facts display a close relation.

A difference among the two IS is their orientation: external and internal. One IS displays an external orientation: It is a system that has to connect with the outside. The driver for the need of flexibility in this IS, is the formulation of a strategic decision to engage in a partnership. This decision implies the need to adapt the elements in order to implement the partnership.

The other IS displays an internal orientation: it is a system that operates inside the boundaries of the firm. Its need for flexibility comes from the fact that the firm must respond to competitors' moves on time by taking strategic decisions with the aid of information. It is a system linked to decision-taking surrounding the market-products in the firm (i.e. decisions to launch new services or to take commercial offers such as lowering prices).

Another difference between the two case studies is the relation between the time a strategic decision is taken and the time flexibility is needed in the IS.

The time when the strategic decision is taken related to the time flexibility is needed, varies in the two cases as follows:

In the case study with external orientation, the events take place in the following order: first, there is a strategic decision made to engage in a business relation with other external operator and then, this strategy is implemented internally in the company (the agreement signed to close the business relation must be quickly implemented by affecting the elements in the IS involved). This means that first a strategy was decided and then, flexibility to implement it is needed. The management first decides the strategy, then, they implement it with a flexible system

The situation is different in the case study with an internal orientation, in this system the events take place in the following order: first, the technology is installed (and all the elements in the IS deployed correctly) to be ready to change in case it needs to adapt for extracting information, and then, with this information the strategic decisions is made: the flexibility for extracting data is needed before strategic decisions is taken. For example, the marketing studies conducted use information for launching a commercial product or service; certain information about the customers (like the usage of their mobile for the last 12 months) may be needed in order to decide how to launch it. Figure 4.1 shows the two different approaches.

Information System to connect with the outside (external orientation)

Strategic decision is taken before	→	The business partnership is important A link to strategic agreements	→	Once they have closed the partnership, there is a need to change the IS to quickly implement the agreement signed.
Information Systems that operates inside the boundaries of the firm (internal orientation)				
First the company needs to quickly extract information (and be ready to change in case it is needed to get some data)	→	The market share is important A link to market reaction	→	Once they have information (and flexibility was used): Strategic decision is taken after

Figure 4.1 Need for flexibility in relation to strategy decision in the two case studies.

This conclusion that can be drawn is that the flexibility enablers needed for an Information System are contingent upon its unique characteristics. For example, their orientation (internal/external) and the timing when they need to be flexible (in relation to strategy formulation). Two contingent variables can be identified: orientation and timing in the need for flexibility.

The relation between the flexibility enablers and the time when flexibility is needed is as follows:

1) When the strategic decision is taken before there is a need for using the flexibility of the IS (as in the first case study where flexibility is used to implement the strategic decision of having a new business partner), then, the flexibility of that IS should be based on well documented and standardize business processes, multiskills in the business people involved, the presence of an IT facilitator in the business unit to

support quick IT decisions, Knowledge of the Business by the IT people to implement correctly, functional modularity, Parameterization, Interfaces standardization and Technical Modularity, in the technology used and finally, data clearly standardize in the business unit.

2) When the strategic decision is taken after the flexibility of the IS is needed (to implement a change aimed at extracting data as in the second case study) then the relevant flexibility enablers of the system are: the independence of business processes, the presence of several skills in the business people, the presence of an IT facilitators to complement the Business skills, the correct Knowledge of the Business unit they support by the technical people involved and also the Broad knowledge of other units, from the technology used the functional modularity, parameterization, interfaces standardization and technical modularity; data standardize and independent from the application (in order to be easily accessed) and scalable data.

The flexibility enablers are also contingent upon the orientation, weather it is internal or external.

1) When systems have to connect with the outside (as in the first case study whose type has an external orientation), then the external standardization at all levels (in business process, IT application and business data) enables them to communicate by clear predefined rules. As these standards are used by several entities in the industry they are less prone to changes so data or processes do not necessarily need to be independent and processes can be link to others with no effect on flexibility.

2) For systems that operate inside the boundaries of the firm (as in the second case study whose type is oriented to internal operation) being flexible means to have process decoupling, multiskills, IT facilitator, knowledge of the business, broad knowledge, functional modularity, parameterization, interface standardization, technical modularity,

data standardization, data independence from application, location free access, data Scalability,.

Another conclusion that can be made is that although there are different flexibility enablers contingent the specific characteristics of the IS; some others are always important. For all systems (regardless of its type) there are several conditions that must be met to enable them with flexibility:

For the people working in the IS, all the business enablers should be present (having multiskills and the presence of an IT facilitator in the business unit); the IT people should understand well the dynamic of the unit they are to support (knowledge of the business). The technology used must be designed in such a way that it is very flexible; this implies that all the enablers in the IT dimension are required (functional modularity, parameterization, interfaces standardization and technical modularity) and data standardization.

Table 4.3 shows the flexibility enablers that were found to be relevant for all IS.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business	Technology
Well documented	Well defined software process	Multiskills	Knowledge of the business	Functional modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical Modularity		Location free Access
Process decoupling							Data Scalability

Table 4.3 Flexibility enablers relevant for both case studies

Regardless of the IS, we can conclude that the people and the technology should be well rounded with all the flexibility possible. The difference, when planning to enable the IS with flexibility, lies in mainly in the processes and data dimensions; the enablers relevant for them are, as explained before, tightly link to contextual characteristics like the orientation (external to interact or internal to operate) or the time when the flexibility is needed. From the different flexibility enablers displayed in the Table 4.3, some conclusions can be drawn.

Well defined software processes.

In certain cases (DWH) is good for flexibility to have more rigid development processes (very well defined) . In certain cases it can be better not to have so well defined software processes as this can make them free to react as needed and thus be agile. .

The general comment about a recommendation on whether the IT processes should be well defined or not, is that in some cases it is relevant for flexibility (as in the case with external orientation) for others is not (as in the case with internal orientation). Having well documented business processes is not important for the case study with internal orientation because each business unit in the company has their own processes. In this case not being formal in the processes performed helps them being agile. For the case with external orientation, it is important because they must engage in high interaction with their business partners and other business units.

IT processes and the ITIL framework of reference

Some frameworks oriented to accurately defined how the processes for the provision of IT services (design, maintain, deliver, etc.) should be (i.e. ITIL) do not, per-se, highlight the importance of flexibility; they are oriented to a tight control of the operation. We can see from the findings of the case studies that well defined software processes is not a

always a flexibility enabler. More relaxed processes (that is, less rigidly defined) may allow to be more agile.

This does not mean that an approach to follow processes' frameworks such as ITIL is contradictory with flexibility. ITIL is an umbrella of good practices related to processes; it includes the accurate definition of all processes involved in IT (i.e. maintenance, development, delivery, etc.). But this does not mean that a firm should have all those processes well defined according to the ITIL framework. The firm must choose, according to its context and needs, which are the ones that must be well defined in order to have control of the operation. In the same manner, for flexibility, the firm must choose (according to a particular contextual situation and characteristics of the IS) which processes must be well defined and which ones don't. One must find the right balance between flexibility and ITIL. This work can be taken as a guideline to decide how to implement ITIL processes and be flexible at the same time depending on a specific situation.

IT skills

The people in IS that are oriented to external interaction, are more specialized in their way their unit operates (knowledge of the business); according to the findings, they don't have broad knowledge (they do not know the dynamic and operation of several business unit where IT is employed) so they have well documented business processes. For the IS oriented to internal operation, the landscape is different: the technical people have a certain degree of knowledge of several business units, so they do not need business processes well documented to be agile when deciding or implementing an IT solution.

Information Technology

The results show that for any technology used, it is very important not only to have technology with which is correctly designed but also to have functional modularity, parameterization, interface standardization and technical modularity. That is, it is

important to have mandatory enablers that must be present in IT, but, for the IS this is not enough (there should be other enablers according to context and specific situation).

Data

There are different enablers in the data (stored, used and manipulated by the IT) that support a certain flexibility of a system. For systems where the data comes mainly from inside the business unit, accessing data without the need to know where it is located is not a problem (location free access); for systems that need data from many business unit, the location-free access flexibility enablers is important.

Standardization

The data used in the system to connect with the outside is highly standardize (as in the case with external orientation) so its independence from the application is not important because everyone is using the same specification. It is not important also because of the fact that the standardization comes from an external body. Outside standards do not change often so it is not important to have data independence (which is not desirable in general because changing the data format could mean recompiling and affecting several lines of code) because they will not be subject to change. When an external body does not impose data standardization, it is optional to have data standardization inside the company (as in the case with internal orientation). In this case it is good to have data standardization to easily cross information because the IS is closely linked to market decision and the time to respond is very important.

The findings of both case studies (conducted to evaluate the hypothesis that not all enablers are the same for every IS) show that the elements that sustain flexibility are not the same for every IS; they depend on certain characteristics of the specific IS. The fact that the elements or enablers needed to sustain flexibility are different can be

explained by the polymorphic property of flexibility: for an IS, flexibility displays the same polymorphism characteristic found in strategic flexibility.

The answer to the research question of *how IS flexibility can be achieved*, lies in the flexibility enablers needed for an specific IS. From a practical point of view this means that the managers involved in flexibility decisions or initiatives should understand that there are flexibility enablers in the resources of a firm that can be deployed or acquire. Then, they should become familiar and understand them. But in order to really enable a particular IS with the correct set of flexibility enablers (or the correct form of flexibility needed) it is very important that these enablers be selected according to the unique characteristics of the IS in hand. The conceptual IS flexibility framework developed in this research and the findings presented as a result of two case studies (of two different flexible Information Systems tightly linked to changing strategies) conducted, constitutes a valuable guide for managers to deploy flexible IS to rapidly adapt them when faced to changes needed for strategies implementation in a continuous manner.

Chapter 5 Conclusion

Chapter 5 Conclusion

5.1 Synthesis of results from the research

In this research the main concern studied was to build flexible Information Systems. This topic was found to be relevant as some enterprises are faced with turbulent environments that impose them the need to constantly shift their strategies. These strategies need to be put in practice; this means that at an internal level of the firm there must be some changes done. Among those changes, there are some aimed at the Information Systems. When changes must be done in an IS, it is relevant to enable them with flexibility because this means that they will change easier. Hence a suitable question for the study of IS flexibility was defined as: how can IS flexibility be achieved?

With the ancillaries following questions: Is there available a standardized and unified concept of IS flexibility? How can IS flexibility be assessed?

The first step towards answering this question was to understand what should constitute a suitable way to approach the study of an IS.

This research found (by analyzing previous definitions of an Information System) that there are several dimensions that compose an IS (people, process, data and IT) and that these dimensions should be included to analyze how to achieve and assess flexibility in an IS.

Then, it was deemed as important to find a suitable definition for IS flexibility, because the hypothesis posted was that an integrated and unified concept for IS flexibility was not available already in the literature of IS. What was discovered after reviewing previous definitions of IS flexibility was that they lacked to include the four dimensions found for an Information System. Basing on these definitions a suitable one for IS flexibility was proposed. For this research, IS flexibility was defined as the capability of

the human and IT resources that collect, process, store and output information to adapt to changes so that new business tasks can adequately be performed in a continuous manner.

This definition has several elements implicit that make it suitable. It acknowledges what previous research had uncovered: that in a firm there are resources that are linked to flexibility because it is in them that flexibility resides. It also acknowledges that flexibility is aimed at adapting to changes and that it is not an isolated event but more like a process because adaptation should be continuous.

Finally, it has a mention to all elements that must be covered when referring to an IS. The inclusion of these elements was important to really cover the subject on Information Systems; but also because it has been found that flexibility must be studied holistically by including all elements in the problem viewed. This definition helped cover this gap.

A literature review on flexibility at several levels (i.e manufacturing, strategic, and in Information Systems) conducted provided with several lessons: that flexibility can be approached by characteristics of resources that support the ability to change easily (called here, flexibility enablers). For this research this finding provided the basis to conclude that there are certain flexibility enablers (utilizing a RBV) that provide a system with flexibility.

It was also found that the flexibility enablers are not the same in every case. The elements that sustain flexibility are different depending on the specific Information System analyzed because flexibility is polymorphous. That means that the correct form of flexibility for a particular system is not the same for a different one. What constitutes a particular form of flexibility is a singular set of flexibility enablers. Hence, the particular flexibility enablers that bring flexibility into an IS are not necessary the same for other system. All these facts (resources as flexibility enablers, polymorphous nature and contingency upon the particular characteristics of the IS at hand) were taken to consider that there were gaps to be filled in the study of IS flexibility.

They constitute gaps to be filled because, up to the best knowledge of this research, there was no work found to include: the flexibility enablers that provide with flexibility to an IS (using the four dimensions and a RBV) and recognition that the correct enablers are contingent upon a specific Information System.

To help guide the study, and answer the research question (how can IS flexibility be achieved? and how can IS flexibility be assessed?), it was found a suitable step to define a conceptual framework for IS flexibility. In this point of the research, the posted hypothesis that a valid conceptual framework on IS flexibility enablers can not be designed from IS and management literature at present was found to be true. It showed how the contingency theory, the strategic alignment model and the resourced-based view provided theoretical elements for developing a valid conceptual framework on IS flexibility enablers.

The conceptual framework for IS flexibility was first articulated by reviewing literature on IS flexibility and extracting the relevant findings according to what it was needed: extract flexibility enablers (because they were found to sustain flexibility), use the four dimension (because they constituted a complete view of an Information System), use a resourced-based approach (because resources would be the flexibility enablers in a firm) and introduce a contingent approach.

The complete articulation demanded to considered what was the driver to have flexible Information Systems: the driver, for firms faced to uncertainties, was found to be the timely implementation of strategies in the people, processes, IT and data that compose their Information Systems. The model of Strategic Alignment was a suitable model because it mentions elements (from this four dimensions) that need to be changed to implement strategies in a correct way; that is, in such a way that there is coherence (or alignment) between the strategies defined and the way they are implemented.

The conceptual framework defined is shown in figure 5.1.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business process	Technology
Well documented	Well defined software process	multiskills	Knowledge of the business	Functional Modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical modularity		Location free access
Process decoupling							Data Scalability

Figure 5.1 Conceptual framework

This conceptual framework contains the concepts and flexibility enablers articulated for IS flexibility. But there was still the need to accurately understand how IS flexibility can be achieved because not all the elements (or flexibility enablers) in the framework must be present for all Information Systems. The contingent approach deemed as suitable demanded that the specific characteristics of an IS be considered to define what elements are relevant.

To do that, two case studies were the core field study in this research. They were selected to test the hypothesis that the flexibility enablers are not the same for every IS. The cases selected were both closely link to strategies, this means that they were both faced to changes in order to implement strategies (the driver for the need of IS flexibility) they were both also considered as flexible in the firm. Although they shared these characteristics, they were selected also because they had differences. This would allow extracting from them the flexibility enablers in the framework that enabled them to implement strategies. By comparing the relevant flexibility enablers from both cases, it could be seen if the hypothesis stands or not.

The results showed that the two cases do not have the same enablers from the framework. The enablers were contingent upon certain characteristics particular to each IS. One IS has the characteristic of an external orientation; it is a system whose nature is aimed at high interaction with other firms; the other IS has an internal orientation as it

is a system that operates inside the boundaries of the firm. The timing when flexibility is needed is different in both cases too.

For one, the strategic decision is taken and then flexibility is needed to implement it. For the other, flexibility is needed because the system must be adapted to gather information that will be used to define a strategy.

Two contingent variables were found: the orientation and the time flexibility is needed respect the time the strategic decision is made (before or after). These variables made that flexibility enablers were different.

For example, for systems that have to connect with the outside (as in the first case study which has an external orientation and is highly subject to standardization imposed by a regulating external body) the external standardization at all levels (in business process, IT application and business data) enables them to communicate by clear predefined rules. As these standards are used by several entities in the industry they are less prone to changes so data or processes do not necessarily need to be independent and processes can be link to others with no effect on flexibility.

For systems that operate inside the boundaries of the firm (as in the second case study whose type is oriented to internal operation) being flexible means to have process decoupling, multiskills, IT facilitator, knowledge of the business, broad knowledge, functional modularity, parameterization, interface standardization, technical modularity, data standardization, data independence from application, location free access and data scalability.

The results from these case studies show that on one hand there are flexibility enablers that are relevant according to the specific IS, but on the other hand, there are some enablers that are always relevant. They are shown in Table 5.1.

Processes		Skills		IT		Data	
Business	IT	Business	IT	Applications	Technology Configuration	Business	Technology
Well documented	Well defined software process	Multiskills	Knowledge of the business	Functional modularity	Interfaces standardization	Data standardization	Data independence from application
Process standardization		IT facilitator	Broad knowledge	Parameterization	Technical Modularity		Location free Access
Process decoupling							Data Scalability

Table 5.1 Flexibility enablers relevant for both case studies

For every IS, regardless of its characteristics (or contingency variables), it is relevant to have very flexible people (well rounded with multiskills including knowledge of the business dynamic and IT understanding) and very flexible technology.

The findings of both case studies (conducted to evaluate the hypothesis that not all enablers are the same for every IS) show that the elements that sustain flexibility are not the same for every IS; they depend on certain characteristics of the specific IS. The fact that the elements or enablers needed to sustain flexibility are different can be explained by the polymorphic property of flexibility: for an IS, flexibility displays the same polymorphism characteristic found in strategic flexibility.

The answer to the research question of *how IS flexibility can be achieved*, lies in the flexibility enablers needed for a specific IS. There are several resources (shown in the conceptual framework) that sustain flexibility (called flexibility enablers); but the correct set must be defined for a particular IS analyzed. Not all enablers are relevant in every case. It must also be considered that to achieve IS flexibility resources to sustain it must be from the four dimensions that compose an Information System: people, data, IT and processes.

5.2 Contribution of the research to the field

Previous findings in the field of flexibility gave the underpinning of this research. It was through findings of scholars that the research of IS flexibility was possible. And now this work can contribute to increase the knowledge of the field. Traditionally, flexibility was approached by trying to determine what elements sustained it; and thus factors for flexibility were discovered. In this approach, the more of these factors that the firm had, the more flexible it was. This research contributes to comprehend that flexibility is not the same for every Information System; the precise enablers are contingent upon their characteristics and environment.

It also contributes to specify, more accurately the problem of flexibility in an Information System, which is not the same as flexibility in IT. There are specific dimensions (people, process, IT and data) that must be covered to have a complete view of an Information System. These dimensions are also important to be covered because they constitute a foundation at an internal level of a firm where the implementation of strategies takes place and thus all elements should be included as they have an impact on strategic alignment. Performing changes in such a way that strategic alignment is achieved (or maintained) help to keep the value of IT investments.

Emphasizing the fact that the problem of flexible IS is linked to strategic alignment and to the internal resources of the firm where strategies are implemented is a contribution too; it implies that IS flexibility is an aid for dealing with internal adaptation. This differs to the view of strategic flexibility where the main problem addressed is the external adaptation of the firm with a changing environment.

5.3 Implications for professionals

From a practical point of view this research is a guide for the managers involved in flexibility decisions or initiatives because it helps them to understand that there are

flexibility enablers in the resources of a firm that can be deployed or acquire. It is also important for them to know which the flexibility enablers for an Information System are. But in order to really enable a particular IS with the correct set of flexibility enablers (or the correct form of flexibility needed) it is very important that these enablers be selected according to the unique characteristics of the IS in hand. The conceptual IS flexibility framework developed in this research and the findings presented as a result of two case studies conducted (of two different flexible Information Systems tightly linked to changing strategies), constitutes a valuable guide for managers to deploy flexible IS to rapidly adapt them when faced to changes needed for strategies implementation in a continuous manner.

From an economical point of view it is better to deploy flexible Information Systems with the correct set of enablers than trying to have all the existent flexibility enablers.

5.4 Limitations

In the present research two case studies were selected; both are Information Systems that belong to the same setting (same firm). The same setting allowed isolating variables that could come from different companies such as corporate values, services provided, number of personnel and financial resources. On the other hand, the selection of multiple settings could have uncovered if other variables or elements affect the flexibility enablers. For example, the relevant flexibility enablers could be different if the company is faced to fewer resources. Including other settings could uncover other aspects that answer the question of how to achieve flexibility in Information Systems more deeply.

In a hypothesis testing research an approach can be to define the population of the phenomenon observed, and then select the research sample from them Eisenhardt (1989). In the present research, the population considered was the Information Systems close to strategies (as they are directly affected by changes) in a firm faced to

uncertainties and considered as flexible. From it, two case studies were selected. This narrow in the population could have expanded to: 1) more than one firm faced to uncertainties or 2) firms in several sectors, because this would have added to the analysis external factors such as being subject to a certain degree in regulation or socio-political conditions. This could allow seeing if variations in external conditions will produce different case study results; it could also allow making conclusions on the enabling of flexibility that can be applicable across different types of organizations.

The number of cases deemed as necessary or sufficient for a research using the case study method must be thought as a reflection on the certainty wanted in the multiple case results (Yin, 2003). In this research, the number of case studies was suitable to attain certainty in the analysis of the hypothesis; but it is a limitation for a higher degree of certainty. To attain it, it would have been better to include more case studies in the research.

5.5 Directions for future research

For further research, then it would be suitable to include the cases mentioned as limitations. It would also be good to have case studies of different nature: in this research the two cases were selected because, besides being close to strategies, they were considered as flexible. This allowed extracting the flexibility enablers in them. The inclusion of non flexible system could help reveal other forms of flexibility; that is a different set of enablers relevant under those characteristics.

It is also suitable that findings can be validated on Information Systems that are similar IS (systems having the same characteristics).

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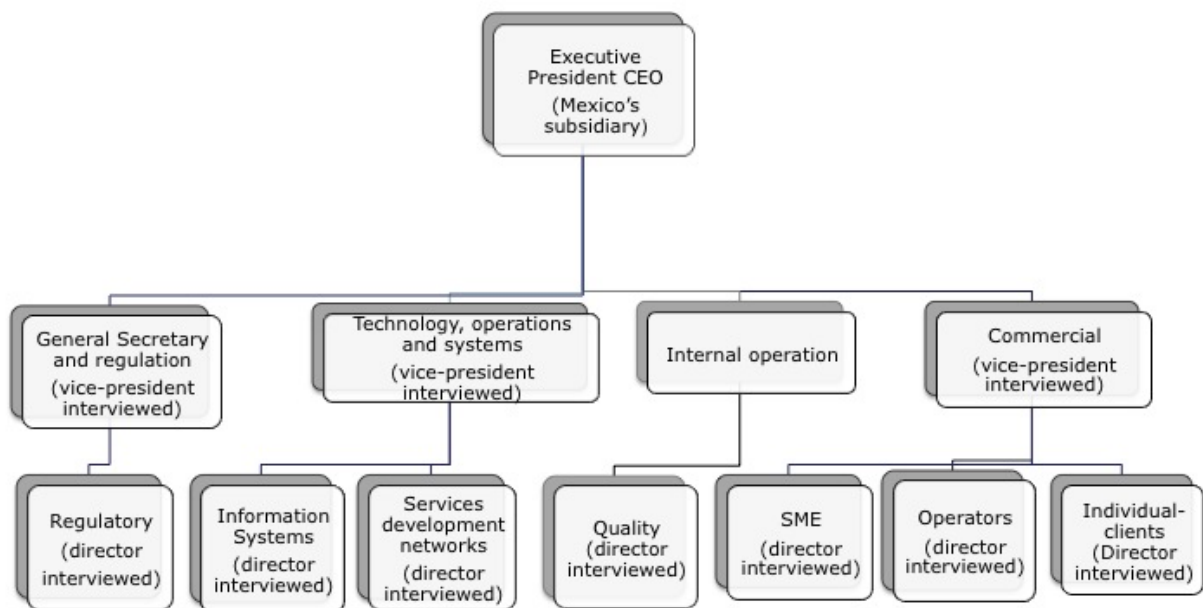
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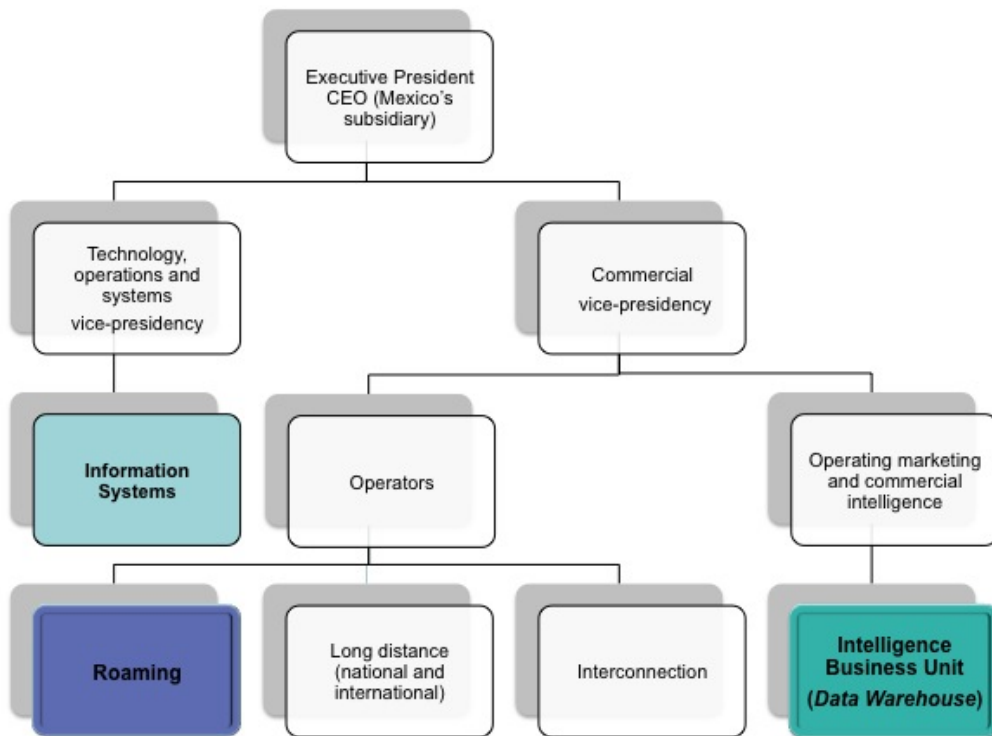
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Appendix A



Exploratory field study
Position of the interviewees in the hierarchy of the organization

Appendix B



Case studies
Position in the hierarchy of the organization

Appendix C

Extracts of the interview to the Information Systems Director

Original Text (Spanish)	Text (English)
<p>Dentro de esta unidad de negocios de IT existen 4 unidades: Las primeras tres (red, negocios y Sistemas) son de inversión, es decir, tenemos presupuesto de inversión. Yo tengo la de Sistemas. Y la cuarta opera todo, es de operación.</p>	<p>In the IT division there are 4 units: the first three (networks, business and Information Systems) are of investment, that is, we have budget to invest. I have the IS unit. The fourth operates everything: it is the operation unit.</p>
<p>Tenemos todos los BSS y un porcentaje de los OSS. Los OSS que son muy cercanos a la red los maneja directamente el área de red. Tenemos los sistemas de gestión de red que hay quienes lo consideran como OSS y otros BSS. Con otra persona están todas las plataformas de servicio.</p>	<p>We have all the BSS and a percentage of OSS. The OSS that are very related to the network belong to the network unit. We have the network management systems. Some people consider them as OSS but others as BSS. With other person (director of the services development unit or business unit) are all the platforms for the different services.</p>
<p>los criterios para decir que son los principales es Por que están más cercanos al usuario o por que la operación esta basada en ellos. Por ejemplo el SCL es el corazón de todo, sin ese sistema no vendes no atiendes al cliente, no facturas no haces nada. Interconexión, roaming y mediación esta en el flujo de ingresos, si no los tengo no puedo facturar, son los que están mas en el flujo de ingresos de la compañía. El data warehouse se ha convertido en un sistema que es importante para proveer información a muchas áreas, para poder tomar</p>	<p>The criteria to classify them as the main is that they are the ones closer to the user or because they support the operation. For example the SCL is the heart of everything: without those systems we cannot sell or bill the customer. It has many commercial functions in it.</p> <p>Interconnection, roaming and mediation are systems that manage part of the income flow; if we did not have them we could not bill anyone.</p> <p>The data warehouse has become an</p>

<p>decisiones, ver tendencias. Mucha de la información que sale del data warehouse alimenta a otros subsistemas. Por ejemplo tenemos un sistema de gestión de campañas, para gestionar campañas de retención o de ventas a nuestros clientes. Por ejemplo imagínate que tú eres un cliente de prepago y recargas todos los viernes y de repente dejas de recargar. En base a tu comportamiento vemos que algo pasa entonces podemos decir: mándale un mensaje a ver si no se nos esta yendo con otro operador. Este sistema de campaña se alimenta del data Warehouse. O sea da información no solo a personas sino a otros sistemas.</p>	<p>important source of information to other units to make decisions, to forecast trends and other things. Many if the information that comes from the data warehouse is the input to other systems. For example we have a system for managing sells campaigns or fidelity campaigns for our clients. Imagine that you are a prepaid client who usually recharges every Wednesday and suddenly you stop recharging. Based on your consumer patter we can see that something is happening. We can decide to send you a message to see what is happening. This campaign system gets its information from the data warehouse. So the data warehouse provides information for people and systems.</p>
<p>Estos sistemas se han enfrentado a muchos problemas. Por ejemplo el SCL es un sistema muy grande que se desarrollo en Chile por una subsidiaria. Fue creada para desarrollar este sistema. Actualmente esta operando en 7 lugares: aquí, Panamá, nicaragua, ecuador, Colombia, chile y argentina. Entonces en vez de tener un sistema comercial tenemos este sistema que es desarrollado para nosotros en México y otros países. El principal problema del sistema es que es una tecnología no muy reciente y que cambiarlo es muy difícil. Si yo pido un cambio hoy (sep.) lo voy a ver en el primer trimestre del año próximo si bien me va, unos 5-6 meses aprox. Yo no tengo la flexibilidad de cambiarlo aquí, se tiene que hacer en chile. Y como dije cuando solicito un cambio tengo que esperar unos meses. La</p>	<p>These systems have faced many kinds of problems. For example, the SCL is a system developed in Chile. This company was created to develop this system. The SCL is nowadays in production in 7 countries: México, panama, Nicaragua, Ecuador, Colombia, Chile and Argentina. So instead of having a commercial solution we have this systems. The main problem we face is that it is old technology and so it is difficult to change. If I request a change let say today, I can expect to have it done for the first trimester of next year. That is 5-6 months. I don't have the flexibility to change it here in Mexico; the change must be done in Chile. And as I said, I must wait months for a change. The advantage was that due to the fact that it</p>

<p>ventaja es que como lo desarrollo esta compañía para ellos mismos no se paga licencia a un tercero. Que es una ventaja relativa.</p>	<p>was developed by a subsidiary we don't pay for licensing. It is a relative advantage.</p>
<p>En agosto de cada año nos reunimos con todas las áreas y nos dan sus necesidades para el año siguiente. En base a eso se elabora un presupuesto anual de inversión de sistemas. Una vez que se aprueba ese presupuesto empezamos a trabajar en esos proyectos y en las necesidades cotidianas. En cada área usuaria existe una persona identificada que registra en un sistema sus necesidades llenando un formato. Eso alimenta una oficina de proyectos nuestra. Es un grupo que gestiona esa demanda de peticiones y va asignando a los diferentes grupos de desarrollo. Yo tengo 6 grupos de desarrollo que atienden a las diferentes áreas. Por ejemplo un grupo atiende a ventas, otro a clientes, otro a empresas y así.</p>	<p>Every year in august we gather with other units to know their needs for the following year. Based on that a system budget is planned. Once the budget is approved we start to work on those projects and on the everyday requests. Every unit that is our user there is a designated person that registers in a system their requests by filling a format. That is the input for a project group in this division. The project office is composed by several people that allocate resources to the development groups. I have 6 development groups to serve the user units. A manager leads each development group.</p>
<p>un gerente por área para que estén más cerca de su área cliente. Estos grupos se forman de un gerente y otras personas como analistas internos y externos. Un grupo se encarga de atender a una o dos áreas. Su experiencia se va desarrollando en la experiencia del área que atienden</p>	<p>One manager per unit so that each manager can be close to its user, that is close to the business unit that is its client. These groups are formed by: a manager and other persons such as internal and external analysts and programmers. Each development group is responsible for serving one or two units. Their expertise is developed around the unit they are responsible for.</p>
<p>Mis principales usuarios son: Área de clientes, área de operadores (esta área lleva interconexión, roaming, mediación y larga distancia son quien tienen relación con otros</p>	<p>The units that are my main users are: clients unit, operators unit (this unit handles interconnection, roaming, mediation, long distance. This unit is the</p>

<p>operadores de aquí de México y otros países), el área de finanzas demandan mucho. En general las áreas comerciales</p>	<p>one that has the direct relation with other telecom operators here in México and other countries) finance unit, etc. the commercial areas in general.</p>
<p>En cuanto a gente son estos 6 gerentes que atienden a 1-2 áreas y cada uno tiene un grupo de trabajo y un presupuesto. Hay flexibilidad de cambiar el presupuesto del área usuaria, si deciden que la prioridad cambio pues se puede pasar el presupuesto a otro proyecto dentro de esa misma área. Así que cada gerente conoce muy bien los proyectos de su cliente o usuario y gestionan los proyectos de esa área.</p>	<p>As far as people goes this 6 managers take care of 1 or 2 business units. Each team has human resources and a budget. There is flexibility to use the approved budget for each team. The user can decide the priority of their projects. If they decide to change the priority, the budget can also be reassigned. The only restriction is that it must be reassigned to other project of the same unit.</p>
<p>Puede haber problemas con esta estructura. Un caso es por ejemplo: el área de red es muy grande y maneja mucho presupuesto tiene más del 60% del presupuesto, las áreas de servicios y sistemas somos muy parecidas en tamaño. Entonces lo que puede pasar es que el foco del PMO este más centrado en red y que nosotros estemos desatendidos.</p> <p>Las funciones del PMO estaban en sistemas y se pusieron en otro nivel para atender a toda la vicepresidencia así que yo estoy tranquilo por que conozco lo que se hace.</p> <p>Otro problema que se me ocurre con esta estructura es en el tema económico. A lo mejor tienen que hacer compras millonarias en el tema de red y yo que estoy comprando lap tops y PC a lo mejor no le ponen la prioridad que yo quisiera. Otro caso es que el área de servicios este redefiniendo muchos procesos y yo quiero</p>	<p>There can be problems with this structure. One case is for example: the network unit is very big and has a big budget, more than 60% of it. The service units are smaller and similar in size. It can happen that the PMO has its focus more on the network unit due to its size. It can happen that I end up unattended. On the other hand I am very confident with this structure because the PMO functions used to belong to my unit so I know them very well.</p> <p>Another problem that comes to my mind with this structure is economic related. Probably they must make network-related big investments and I must buy PCs and lap tops. And my acquisitions may not have the priority I would like.</p> <p>Another hypothetical case can be if a unit is redesigning many processes and I want to make a small process change and end</p>

<p>hacer un cambio y no se me atiende.</p> <p>Pero en general funciona muy bien y se optimizan los recursos así como también se tiene una visión global de toda la vicepresidencia.</p>	<p>up un-attended.</p> <p>In general it functions very well, resources are optimized and there is a global vision of all the vice-presidency.</p>
<p>En mi experiencia lo que debe de ser es que un cambio esté a tiempo, que este bien hecho y que este dentro de costo. Pero a veces en la realidad ocurre que debido a que estamos en un mercado muy dinámico la flexibilidad es importante y también el tiempo. Así que esa flexibilidad implica a veces darle al usuario en el tiempo en que lo solicita lo más cercano a lo que pidió.</p> <p>Por ejemplo a lo mejor me esta pidiendo un carro de ultimo modelo y yo no se lo doy de ultimo modelo pero si algo en la fecha en que lo quiere por que si se lo doy después no le va a servir de nada. A veces hay que negociar con el usuario: quieres un auto ultimo modelo? pues tienes que esperarte más tiempo. O quieres algo que se mueva pero en la fecha que lo pides? Y así llegamos a un acuerdo. Hay que gestionar la expectativa con el tiempo. A veces es humanamente imposible darles lo que quiere.</p>	<p>In my experience the measure of success in a change is that things are done on time, functioning well and whiting budget. But in reality this is not always achieved because we are in a very dynamic market and the flexibility is important and the timing too. So that flexibility sometimes means to give the user in the time he needs it something pretty close to what he asked for.</p> <p>To make myself clear let's suppose the user asked for a brand new car. I may not give him a brand new car but instead a car in the time he needs it. If I wait until I can give him the brand new can he may not need it anymore. Sometimes that means to negotiate and come to an agreement with the user: do you want a brand new car? Because you may have to wait longer or do you want some vehicle to move but in the time you need it? That way we can negotiate. One must make expectations and time agree. Sometimes is humanly impossible to give them what they want</p>
<p>estos cambios o requerimientos los motiva de todo, un tema de negocio. hay muchos requerimientos por nuevos productos, nuevas ofertas, cambios operativos de área, iniciativas nuevas de diferentes áreas. Hay de todo pero siempre es un tema de negocio.</p>	<p>Many things motivate the main change initiatives. Change initiatives or requests always involve a business issue. Many come from a new product, new services, operating changes of units, etc.</p>

<p>Por ejemplo el año pasado el proyecto de operador logístico. Fue un cambio en la forma de operar de la distribución de Terminal de teléfonos. Era un cambio radical en la forma de trabajar. El área usuaria, logística, expuso que iba a cambiar la forma de operar. Había que hacer un cambio en el sistema SCL. El que te comento que no podemos hacer cambios aquí. La única forma de hacerlo fue traerme a la gente de Chile a trabajar aquí y fue súper efectivo.</p>	<p>One example is a project from last year: the project of the logistic operator.</p> <p>It involved changes in the way the telephone distribution operated. It was a radical change in operation. The user unit, logistics, came with that change initiative. Changes had to be done in the SCL, the system that can't be changed here. The only way to have those changes done was to bring the people from Chile to work here. It was super efficient.</p>
<p>En el data warehouse esta gran parte de la información pero si hay cosas que no están ahí. No es una base de datos exhaustiva de la compañía pero si da gran parte de los indicadores principales de operación. Lo que esta más diseminado es lo que esta en los sistemas operacionales como el facturador.</p>	<p>A lot of information can be found in the data warehouse although not everything is in there. It is not an exhaustive DB of the company but it does provide the main operation indicators. What is more fragmented and disseminated is what is inside the operational systems such as the billing.</p>
<p>la independencia del usuario es importante. Que ellos puedan servirse solos. Esto era el objetivo del data warehouse</p>	<p>What is important is the user's independence. It's important that they can "serve themselves". That was the objective of the data warehouse.</p>
<p>En el tema de reglas de compatibilidad o de naming conventions está el tema principal que veo es entre operadores, existen reglas de compatibilidad entre operadores, reglas para compartir información entre operadores. Si yo le voy a facturar a otro operador y el me va a facturar a mí por que nuestros clientes se hablan, el que existan reglas y acuerdos facilita esa comunicación.</p> <p>Los estándares para nosotros están en la misma tecnología, GSM es un estándar que</p>	<p>Compatibility rules, naming conventions is the main issue among operators.</p> <p>Among operators there are a set of compatibility rules and rules to share information. If I am going to bill other operator and he is going to bill me (because of traffic between our clients) we must communicate. The rules and agreement help facilitate this communication.</p> <p>Sometime standards are imbedded in the</p>

<p>permite que los operadores de GSM tengan un forma similar de trabajar.</p>	<p>technology. GSM is a standard that lets all operators (using the GSM technology) have a similar way of working.</p>
<p>Esos estándares de variables y programación no los tenemos. Ayuda pero no nos es fundamental. No somos una empresa de desarrollo de sistemas. Somos un área que no necesita de certificarse en cosas como CMM. No es nuestro objetivo, si lo tuviéramos pues que bien, pero no me es fundamental.</p> <p>Si buscara ese objetivo tendría que dedicar recursos a ello., si lo logramos que bueno le ayuda al negocio pero no es algo que b. No es una actividad "core".</p>	<p>We do not have variables and programming standards in system. It helps but it is not fundamental. We are not a systems development enterprise. We are a unit that does not need of certifications such as CMM. It is not our objective. If we had it, it would be OK but it is not fundamental.</p> <p>If I sought that objective I would have to assign resources. The objective is not to be certified.</p> <p>It is not a core business activity.</p>
<p>En nuestro sistema comercial (llamado SCL) los datos están ligados a él. Yo no lo puedo tocar ni tener acceso a él directamente, dependo de un proveedor y eso me dificulta dar soluciones rápidamente. Por ejemplo, estamos haciendo un proyecto para hacer un portal de activaciones. Hoy en día nuestros distribuidores tienen que hablar por teléfono para activar un teléfono pos-pago. Estamos haciendo un portal desde el cual el distribuidor se conecta, ingresa los datos y activa el equipo. Yo puedo hacer el sistema, pero los datos que necesito están en el SCL y también mi sistema debe dejar otros datos ahí. Así que debo hacer una puerta para poder modificar esos datos que están ligados al sistema.</p>	<p>In a commercial system (called SCL) the data is link to the system. I cannot access or modify the data directly. I depend on a provider and that stops me from giving solutions quickly.</p> <p>For example, today we have a project to develop an activation portal. Nowadays our distributors must make a call to activate a pos-paid telephone (a terminal equipment). We are developing a portal so the distributor can connect to the portal, fill a form and activate the equipment. I am making the portal and system but the data I need are in the SCL. Also the portal must modify information in the SCL. So I must have a door to access data tightly link to the system.</p>
<p>Un mantenimiento eficiente para mi es que pueda hacer el cambio en el tiempo en que me</p>	<p>An efficient maintenance for me is when I am allowed to do a change in the time it is</p>

lo pide el negocio con un costo razonable.	demanded with a reasonable cost
<p>Hemos implementado interfaces que me permitan acceder a los sistemas legacy. Estas interfaces me dan la flexibilidad que necesito.</p> <p>Por ejemplo el sistema de activaciones. Este sistema no se lo puedo poner al distribuidor por la tecnología con que esta hecho, entonces creo algo como un portal, donde pueda hacer la activación.</p> <p>Pero al final la solución se la voy a dar.</p>	<p>We have implemented interfaces that let me access the legacy systems. These interfaces give me the flexibility I need.</p> <p>For example the activation system. This particular system cannot be installed in each distributor because of the technology it was developed with. That is why we are creating the new portal to enable them to activate equipment. At the end I will provide them with a tool.</p>
<p>La clave en este negocio es la reacción. Para mi ser flexible es poder reaccionar rápido. Eso veo en mis proyectos. Aquí no planean mucho, nuestras áreas no ven más allá de un año o más bien 6 meses. Así que si ellos no saben lo que va a pasar pues yo debo de poder responder rápido. Tengo que poder dar soluciones rápidas. Nunca me van a pedir algo para dentro de un año. Eso jamás. Siempre lo que piden es para ayer. Y eso por que así es el mercado.</p>	<p>The key in this business is reaction. For me to be flexible is to react quickly. Something that lets me do that. That is what I can see in our projects. Here in the company they do not plan for long time; our plans are no longer that one-year or 6 months to be precise. So if top executives do not know what is going to happen I must be able to respond quickly. I must be able to provide fast solutions. I will never be asked to finish something for a year. That is never going to happen. Every request is for "yesterday". This is the way this market is.</p>
<p>Nos ha ayudado mucho los cambios en los procesos y el documentar mejor las cosas. Desafortunadamente eso ante los ojos de los demás, ante los usuarios nos empieza a percibir como burocráticos o como lentos. Entre mas calidad le intente meter, entre más controles le intente meter mas me perciben como burocrático o lento.</p> <p>Por ejemplo Sarbanes Oxley lo que busca es tener varios controles en tu forma de operar. El</p>	<p>What has helped us a lot is performing certain changes to processes and documenting more. Unfortunately to the eyes of our users is perceived as bureaucratic or slow. The more quality I try to implement, the more controls I include, the more I am perceived as slow and bureaucratic.</p> <p>For example, what Sarbanes Oxley seeks is to have several controls in the way a</p>

<p>tener esos controles hace que nos volvamos más rígidos o menos flexibles. Hace 4 años aquí una persona podía tocar el sistema y ponerlo en línea así nada mas. Cuando le decían cámbiame esto, lo cambiaba y lo ponía a funcionar tal cual. Eso podía verse como muy flexible, pero pasaron muchos problemas por poder hacer las cosas así sin controles. Por eso ponemos controles.</p> <p>Ahora cuando me piden un requerimiento me lo tienen que firmar, aprobar, lo programamos, etc.</p> <p>Hoy en día yo solo pongo en producción los cambios que se realizan los lunes y jueves. Y tengo que programar el cambio una semana antes y pasar por control de calidad.</p>	<p>company operates. Having those controls makes us rigid and less flexible. Four year ago a person could modify the systems and install it in production just like that. When he was asked by the user to change something he would just do it and put in production. This could have been perceived as very flexible, but a lot of trouble happened for doing things with no controls at all. That is why we have controls.</p> <p>Now when I get a requirement it has to be approved, signed, scheduled, etc.</p> <p>Nowadays we only put into production changes or updates on Mondays and Thursdays. We must program one week ahead and go through quality controls.</p>
<p>Los estándares ayuda a que tengas sistemas mas estables. A que tu operación sea más estable y a reducir la cantidad de incidencias. Pero el negocio te percibe como burocrático y lento. Hay gente que me lo ha dicho. Me han dicho: es que yo antes le hablaba a fulanito. Contesto: pues si, pero ¿Cuántas broncas tuviste por hacer eso?</p> <p>La clave esta en el equilibrio. Ni tener todos los controles ni trabajar como a cada quien se le ocurra.</p>	<p>Standards help to have more stable systems and a more stable operation and to reduce the number of incidences. But the firm perceives you as bureaucratic and slow. Some people have told me so. I have heard from a user: I used to call John Doe and have what I needed. So I have to answer: yes I know, but now tell me how many problems did you have because of that?</p> <p>The key is balance: not to have all kinds of controls and not working as everyone pleases.</p>
<p>El ERP que tenemos lo tenemos en la parte financiera y no ha sido un problema. En realidad tenemos Oracle Financials (que ha funcionado bien) y lo estamos cambiando a SAP pero por una decisión de más arriba. Una</p>	<p>The ERP we have is in the financial unit and we have had no problems. We have Oracle-financial and it is OK. We are changing it to SAP but because of a corporate decision. A Latin-American-level</p>

<p>decisión a nivel Latinoamérica. EL ERP lo podemos cambiar aquí sin problemas, ¿Por qué? Pues por que son aplicaciones preparadas para que tú puedas cambiar tus procesos.</p>	<p>decision. The ERP can be changed here with no problem. And that is because these are applications made or prepared so one can change their processes.</p>
<p>eso estamos estructurados así para que nuestros gerentes de desarrollo conozcan a los procesos de nuestros clientes. Para que sepan como se hace una venta, como se gestiona el inventario, como se activa un teléfono, todo.</p>	<p>We are structured like this so our managers know directly from the users the business process. So they know how a sale is made, how the inventory is managed, how a telephone is activated and so on.</p>
<p>Pues en este negocio es mejor multiskills. Multiskills técnicos, de procesos y de negocios.</p>	<p>In this business it is better to have multiskills. Technical skills, process-related skills and business skills.</p>
<p>Formalmente tenemos un presupuesto que esta dividido en proyectos y ese es el catalogo formal de proyectos. Yo tengo aproximadamente 40 líneas de presupuesto que cada una de ellas esta asociada a un proyecto. Cada gerente maneja un conjunto de esas líneas. Entonces ellos saben perfectamente para que se usara su presupuesto. Y están en contacto directo con su usuario. Pero fundamentalmente es por medio del contacto con el usuario.</p> <p>La estructura que tenemos nos da ese mecanismo. La estructura que hace que estén cerca del usuario nos da esa flexibilidad.</p> <p>Cada gerente a su vez tiene jefes de proyecto que son quienes ya atienden a un área específica. Por ejemplo el gerente de clientes. Ese gerente tiene un jefe que ve los proyectos de facturación y cobranza, tiene uno que ve los propios de atención al cliente, otro que ve lo de activación y así. Entonces estas 2 capas, el gerente y sus jefes, son los que conocen directo</p>	<p>We have a budget that is divided into projects and that is our formal project catalog. I have about 40 lines for the budget each assigned to a project. Each manager handles a set of those projects. They know perfectly well how their budget has to be used. They know the complete detail of the planning through the direct contact with their users. Our structure gives us that flexibility.</p> <p>Each project manager has project leader for each unit.</p> <p>For example the manager for the clients unit. That manager has lider to work in the billing and accounts receivable, other for customer care another one for activation of equipment, and so on. These two layers, managers and project leader, are the ones with the business knowledge. Between them and the users set the priorities. I do not prioritize on my own feelings or instincts, the user does that.</p>

<p>a su área usuaria. Con ellos y el usuario ponemos prioridades. Yo no trabajo por lo que me parezca lo más importante sino por la prioridad del usuario.</p>	
<p>Se me hace más importante el multiskills en gerente y jefes.</p> <p>Pero hay gente a la que se le facilita más que otros. Por ejemplo, a los gerentes los roto. No cada año pero si lo hemos hecho un par de veces. Por ejemplo, el que atendía a clientes ahora va a ver comercial, el que veía comercial ahora va a ver interconexión. Y lo hicimos por que a la gente le das una visión del negocio diferente.</p>	<p>I think multiskills are more important in The first levels, managers and leader. But there are some people who have a natural ability. For example, I sometimes rotate the managers. Not every year but I have rotated them twice or so. For example the client's unit manager was transferred to the commercial unit; the one in the commercial unit was transferred to the interconnection unit, etc. We took the decision to rotate them so they could have a different view of the company.</p>
<p>La rotación en el primer momento fue como un shock. No querían pues decían que tenían dominado su territorio.</p> <p>Claro que moví este nivel (gerente) pero no moví estos (jefes y para abajo).</p> <p>No mueves todo en el mismo momento. A veces cambias la gerente y a veces los jefes. Así también pueden traer ideas nuevas al grupo</p>	<p>Rotation was a shock for them at the beginning. They didn't want to move because they argued that they knew well their territory.</p> <p>I must make clear that I changed the manager but not the project leader. One can't move all at the same time. That way the new manager can also bring new ideas and dynamic to the group.</p>
<p>Veíamos que la gente ya estaba estancada y ciclada en un mismo tema. Por ejemplo un jefe que ya llevaba 4 años viendo mediación y con eso ya desarrollo una habilidad. Si la mueves a otra área donde pueda aportar eso que aprendió antes pues ayuda.</p>	<p>We noticed that people was stalled and like cycled in a same unit.</p> <p>One manager had been in mediation for 4 years; he had more that developed ability for that unit. It could be useful if he was moved to a unit were he could use that ability.</p>
<p>No rotas a todos por que si n o se hace un caos. Pero lo hemos hecho y nos ha funcionado.</p>	<p>If you rotate everyone it becomes chaos. But we have done it and it functioned well.</p>

<p>Ahora también hay que ver con quien lo haces. No con todas las personas por que hay personas que no son tan abiertas.</p>	<p>Now let me tell you that one must also decide whom to rotate. There are some people that cannot be rotated or for which the change is going to be more difficult.</p>
<p>Hay a quien le cuesta más trabajo rotar. Hubo una persona que nos suplico que no la moviéramos. Meses después nos agradecía y nos decía "que bueno que me hicieron este cambio por que ahora veo las cosas diferentes". También les sirve para crecimiento de la gente. De ver una ventana así chiquita ahora ven una más grande. Tienen una visión diferente del negocio.</p>	<p>There are some people who will have a harder time changing and rotating. There was a person, who begged me not to change him; later (after a few months) he was thanking me. He used to say "this change was good for me, now I see things differently". It is good for their professional development too. They have a broader view of the business.</p>

Appendix D

Extracts of the interview to the technology, operations and systems vice-president

Original Text (Spanish)	Text (English)
<p>Aquí hay 2 tipos de cambios:</p> <ol style="list-style-type: none"> 1. Por una parte cambian los requerimientos de nuestro cliente. Nuestros clientes son de 2 tipos: <ol style="list-style-type: none"> a. Aquellos a los que va destinado el servicio b. Y los clientes internos: área comercial, financiero, marketing, etc. Que nos piden a nosotros necesidades que tienen de IT y que tenemos que cubrir. 2. Cambios de la tecnología pues la tecnología en esta industria cambia con bastante rapidez y nosotros debemos de captar esa oportunidad. <p>Cambian las necesidades de los clientes una de cuyas manifestaciones es la oferta comercial que también cambia. La manera en que se cobran los minutos, el tipo de servicios que se les da a los clientes, en como se les vende, el modo de distribución, etc. Todo eso son cambios importantes.</p>	<p>There are 2 types of changes:</p> <ol style="list-style-type: none"> 1. One is that the requirements of our clients change. Our clients are of two types: <ol style="list-style-type: none"> a. Final users that receive our services b. Internal clients or business units: commercial unit, financial, marketing, etc. Who seek for our help to full-fill their IT needs. 2. Changes in technology because the technology in this industry changes pretty quickly and we must take advantage of that situation. <p>The need of our client's change and this is evident when we see that our commercial offerings change too. For example: the way the minutes are charged, the type of services offered, how we sell, our distribution channels, etc. All those are important changes.</p>
<p>El parámetro fundamental para implementar cambios sería el conocerlos a tiempo y por que es así? Por que normalmente las áreas</p>	<p>The most important parameter to implement changes would be to know them in advance. Why? Because the commercial</p>

comerciales de este negocio tienden a pensar que los cambios tecnológicos se pueden introducir con rapidez. Te pongo un ejemplo que creo que lo ilustra bien: imagínate que en el área comercial alguien decide que tenemos que multiplicar los clientes por 4 en un mes. Esto es un ejemplo exagerado. Pero imagínate que alguien lo decide pensando en que vamos a hacer un impulso comercial, unas ofertas increíble, y de una campaña espectacular. O sea que alguien dice dentro de un mes nosotros vamos a tener demanda tal que vamos a multiplicar los clientes por 4. para que eso se pueda hacer las infraestructuras técnicas lo tienen que permitir. No se puede meter en la misma red a los clientes por 4, la tienes que hacer crecer. Eso requiere un tiempo que a veces se olvida. Esta industria tiene un problema, el activo técnico que lo pone en servicio no se ve. Todo lo que no se ve no se entiende.

Si me permites te pongo otro ejemplo:

Si esto fuese una compañía aérea pues saltaba a la vista que para transportar a personas hacen falta aviones. Si tu no tienes aviones no puedes transportar a la gente, eso lo entiende cualquiera. Sin embargo aquí parece que no por que como lo que nosotros vendemos son minutos de uso. Y no siempre se entiende en que para cursar esos minutos hace falta una infraestructura técnica y no se entiende que si no hacemos crecer eso pues no salen más minutos. Eso no se entiende por que el minuto es un inmaterial mientras que el avión es un material.

units in this business or company tend to think that technological changes can be introduced (implemented) quickly. Let me tell you an example to illustrate my point: imagine that in the commercial unit someone decides that we are going to increase our customers by 4. This is an exaggerated example. Imagine someone says so because we are going to make incredible offers and a spectacular campaign. So, someone says: in a month we are going to have such a demand that we are going to multiply our customers by 4. In order to do that the technological infrastructure must support it. We cannot have 4 times more customers in the same network, it must be augmented. This requires a time that sometimes is forgotten. This industry has a problem: the technological assets that make it work are not seen or can't be seen. All that cannot be seen is not understood.

Let me put you another example: if this company were an airline it would be obvious that for transporting people airplanes are needed. If you don't have airplanes then you cannot transport people. Everyone understands that. However it is not that case here because what we sell are minutes of use. It is not always understood that for transporting those minutes a technological infrastructure is needed. It is not understood that if we don't make that grow we cannot let more minutes out. And that is not understood because a minute is not material and the plane is material.

<p>A veces a el área comercial se le ocurre "hagamos una promoción" donde los clientes van a hablar muchísimo durante el día. Pues ese es un problema en esta industria por que las cosas técnicas tienen una capacidad y no se pueden multiplicar por 4. Cualquiera entiende que si tienes una compañía aérea y tienes que transportar más gente no cabe, por que no hay asientos suficientes. Aquí no lo entienden o se entiende menos por la naturaleza del negocio.</p>	<p>Sometimes the commercial unit comes with ideas like the following: let's make a campaign so the clients speak in the phone for longer periods during the day. Well that is a problem in this industry because the technical equipment has a capacity that cannot be added by 4 in an instant. Anyone can understand that one cannot transport in an airplane more people that seats. Here it is not understood or is less understood due to the nature of the business.</p>
<p>Comunicación sería un punto importante y en el que hay mucho por hacer más comunicación.</p> <p>El problema numero 2 sería la previsión. Yo comprendo que es difícil. Si no fuese difícil nadie se hubiese puesto a pensar u optimizar así como tú estas estudiando este doctorado. Si la previsión ayudaría. Hay otro síntoma que es muy claro y que domina esta industria. Es el querer disparar a todo. Además del servicio básico que nosotros vendemos hay otros servicios que se llaman servicios de valor agregado como el buzón de voz, la mensajera multimedia para fotos, el correo. Etc. A ese grupo de servicios que no son la voz nosotros les llamamos servicios de valor añadido. Entonces puedes comprender que SVA te puedes inventar 300. y con la convergencia mas todavía, que si la tele, que si el video. Un problema de esta industria es que se quiere disparar a todo y hay que ser muy selectivo. Y claro hay que acertar y no es fácil.</p> <p>Otro problema de esta industria es que es difícil de anticipar cuál es la respuesta de</p>	<p>Communication would be a good point. And there is lot of things to do in that sense. Problem number 2 would be prevision (planning ahead). I know it is hard to do it. If it were easy nobody would be studying things related to this like you.</p> <p>There is another problem that rules this industry: it is like wanting to shoot at everything. Besides the basic service that we sell there are other services called value added services (VAS) like the voice mail, multimedia messaging, mail, etc. to that group of services different to only voice we called them VAS. Now you can imagine that one can invent 300 VAS. And with convergence even more: TV and video. One problem in this industry id wanting to shoot to everything when we must be more selective. Obviously one must hit the target when shooting and that is not easy.</p> <p>Another problem surrounding our industry is that it is harder to predict the final user's response. The clients' response to new services is slower than we would like. It</p>

<p>nuestros clientes. La asimilación por parte de los clientes sobre los nuevos servicios es mucho más lenta de lo que a todos nos gustaría.</p>	<p>takes time to let people understand products and how to use them; also charges related to services are not understood.</p>
<p>No se puede olvidar que en esta industria surgen nuevos servicios que no hay que desatender. Mi opinión es que lo que no se puede es sobrevalorar. Ese es un error que se ha visto que se ha cometido durante varios años. Es una manifestación en la telefonía celular de la burbuja de Internet. Se pensó que los clientes iban a usar nuevos servicios como la videotelefonía o videostreaming. Hubo un tiempo donde esa forma de pensar adquirió tono de doctrina y todos pensaron que la voz iba a ser algo marginal. Y no, ahora mismo nosotros vivimos de vender minutos.</p> <p>Como ves es muy fácil llegar a modelos distorsionados de cómo las cosas van a pasar. Desde el punto de vista de las cosas técnicas a veces esos modelos han terminado en inversiones que no han resultado.</p> <p>Se pensó que todos iban a usar los servicios WAP para navegar y que de ahí se iban a sacar unos fuertes ingresos y mayor demanda. Yo estoy convencido de que los clientes perciben a los servicios de comunicación como un todo. La convergencia es buena. No conozco muy bien lo que se percibe aquí. En España lo conozco bien: se trato de diferenciar o separar los servicios fijo y móvil, se trato de separar a las compañías y no funciona. Yo trabajaba en la telefonía fija.</p> <p>Aquí hay grandes proveedores y grandes oportunidades de sinergias. Claro que si.</p>	<p>One cannot forget that there are new services that must be looked at. My opinion is that what is unacceptable is to over-value. That is a mistake that has been made for several years. It is like a cellular resemblance of what happened with the internet bubble. We thought that our clients would use videoconferences or videostreaming. There was a time when that kind of thinking took the form of a religion. Everyone thought that voice services would be marginal. But no, nowadays we live of selling minutes.</p> <p>As you can see it is very easy to come up with distorted models of how things will happen. From the point of view of the technology, those models have sometime ended in wasted investments.</p> <p>Every one thought that WAP services would be thoroughly used to navigate and that we would get high incomes from them and a lot of demand.</p> <p>I am convinced that clients see the communication services as a whole. Convergence is good. I know the market in Spain very well. There, the fixed and cellular services were tried to be separated but it didn't work. I used to work in fixed telephony and was moved to the cellular business. Here in Mexico there are great providers and great opportunities for</p>

<p>Es curioso para un observador ver lo que ha ocurrido en esta industria. Esta compañía llegó a tener hasta 4 o 5 compañías diferentes que cotizaban en bolsa de España o de estados unidos. Ahora otra vez existe solo una. Eso se ha manifestado en las áreas técnicas. Las áreas técnicas hubo un momento que estaban separadas y eso era una estupidez por que tienen mucha parte en común. Ya otra vez están unidas. Volviendo a la telefonía celular, yo creo que la gente aun lo esta asimilando. El hecho de que tú lleves un aparatito que puedas hablar y otras cosas es novedoso. O como un iPhone. Todavía las cabezas de algunas personas se están adaptando. Va a tardar en aceptar nuevos servicios.</p> <p>Para contestar a tu pregunta el problema es no desenfocarse. No podemos perder energía, tiempo, dinero, personas valiosas en sacar algo. Es valioso pero cuidado</p>	<p>synergies. Of course there are. It is strange or interesting to see what has happened in this industry. This company got to a point where it had 4-5 companies quoting in stock market of Spain and the USA. Now there is only one again. This has happened in the technical units as well.</p> <p>This happened also in technical units. There was a time when they were separated. This was stupid because they have many things in common. Now they are together again. Getting back to the cellular telephony, I think that people is still getting used to it. The fact that one can take along a device that can be used to communicate is still interesting. Or like the iPhone. Still, some people's head in getting used to it. They will take time to accept our new services.</p> <p>To answer your question, the problem is not to loose focus. We cannot loose energy, time, money, or valuable people to invent something. It can be useful but one must be careful.</p>
<p>Los procesos aquí son fundamentales en mi área. Nosotros tenemos 2 grandes objetivos:</p> <ol style="list-style-type: none"> 1. una es proveer la infraestructura para dar servicio a los clientes. Para que ellos puedan hablar. 2. la segunda es facilitar los procesos de negocio. <p>Las cosas se entienden muy bien con un ejemplo: La portabilidad. La portabilidad tiene detrás de sí un proceso de negocio, una forma de hacerlo, diferentes unidades que intervienen y unas necesidades. Para que la</p>	<p>Business processes here are fundamental in my unit. We have two main objectives:</p> <ol style="list-style-type: none"> 1. One is to provide infrastructure to provide services to clients, so they can talk. 2. The second is to facilitate the business process. <p>Things are well understood with an example: numeric portability. It has a business process behind the concept, it implies a way of doing things, different units are involved and it has several needs.</p>

<p>portabilidad funcione tiene que haber un proceso de negocio. Ahora nosotros no podemos avanzar en la parte técnica de la portabilidad en tanto esas cosas no se decidan como los datos de entrada. Es cierto que cuando hay cambios de esta naturaleza los procesos de negocio tardan en consolidarse. Por que? Por que obedecen a necesidades del negocio nuevas. Tambien existen situaciones de prueba y ensayo en donde la herramienta que te facilita el proceso de negocio pues tiene que cambiar. Ahí también aparecen los tiempos de los que hablábamos antes. No podemos cambiar la herramienta que soporta al negocio de un momento a otro.</p> <p>Un ejemplo más conocido: las recargas. La dinámica de la recarga de los clientes de prepago ha cambiado muchísimo. Desde vender las tarjetas que se rascaban a que un cliente vaya a un cajero y haga la recarga en la caja. Eso no es lo mismo. Eso tiene una repercusión mortal. Lo que hay que hacer para que abonado recargue por una tarjeta es totalmente diferente que cuando va a un establecimiento comercial y lo recarga en una caja. Eso obedece a un cambio en el proceso de negocio: como se hace la recarga, como funciona el proceso de distribución, como son las comisiones de la distribución y todo eso. Todos esos son procesos que necesitan una herramienta que los soporte</p>	<p>In order to have portability there must be a business process (or several but let say one). Now we cannot proceed with the technical deployment for portability as long as those issues are not defined, things like the input data. It is true that when there are changes of this nature it takes time to consolidate the business process. Why? Because the respond to new business needs. There are also situations of try and error when the tool or equipment that supports the business process must change too. There pup-up the times issue we were talking about before. We cannot change tools from one moment to the other. Another more familiar or easy example: recharging credit. The user's dynamics for recharging has changed a lot. From selling the scratch-cards to recharging in an ATM or store. It is not the same, it has big implications. What must be done so a client can recharge credit by using a card is totally different to what the client goes to a store to recharge. This is because of a change to a business process: how the recharge is done, how the distribution process is, how commissions are distributed. All these are business processes that need a tool to implement them.</p>
<p>Los documentos que son para describir los procesos sirven. Eso no es burocracia, es trabajar con orden. Preparar esos documentos a veces tiene una utilidad limitada por que no</p>	<p>Documents that describe processes are useful. That is not bureaucracy, it is working in order. Preparing and writing those documents may have a limited</p>

están bien. Pero eso no elimina su necesidad.	usefulness because they are not correct. But that does not make them a waste.
<p>Cuando un proceso de negocio implica muchas funciones y esas se implantan en un sistema es difícil de cambiar y es complicado. Esta misma mañana me paso. Estábamos discutiendo pues a veces los procesos están tan ramificados que es muy difícil hacer llegar al conocimiento de todo mundo las cosas y que entiendan que el mundo ha cambiado. Que se han cambiado algunos procesos de negocio y que por lo tanto hay que hacer las cosas diferentes. No te imaginas la dificultad tan alta que eso es. Hay personas que todavía piensan que las cosas se resuelven como se resolvían hace un año.</p>	<p>When a business process implies many different steps or procedures, and those are deployed in a system, it is difficult to change and complicated. It happened to me this morning. We were arguing because sometimes process are so sub-divided that is difficult to let everyone know that it changed. It is difficult to let people know that things have changed, that several business process have changed and as a result things must be done differently. You can imagine how difficult that is. There are people that still think that things are solved the exact way they were resolved a year ago.</p>
<p>Yo creo que para aumentar la flexibilidad en todos sentidos hay que huir de especialistas. Bueno, en todos lados deben de existir especialistas monotema. Pero el tener muchos especialistas monotema es un serio problema.</p> <p>Aquí tenemos que movernos entre 2 extremos, los especialistas monotema que serían la parte de segmento. Y los que pueden hacer de todo, que serían la otra parte de segmento. Ninguno de los 2 extremos obviamente es manejable en la práctica. Al menos en la unidad en la que yo me muevo un buen modelo es: que todo mundo tenga su componente de especialización pero que sea capaz de hacer las tareas laterales. A veces hasta se los he tratado de dibujar. Todos tenemos que tener nuestro punto de máxima competencia pero tenemos que ser capaces de desplazarnos a un</p>	<p>I think that to increase flexibility one must run away of specialists. Of course that there must be specialists. But having many specialists is a serious problem.</p> <p>Here we move between two ends: the specialists for and the ones that can do almost anything. Any of the two ends are good in practice.</p> <p>At least in the unit I am in a good model is: that everyone has a degree of specialization but at the same time be capable of doing lateral tasks. I have tried to draw this idea to my people. (<i>At this point the person talking draws a standard deviation curve</i>)</p> <p>We all must have our point of highest competence but we must be able to move to one end of the curve or the other relatively easy. We will not be the best but</p>

<p>lado y a otro con bastante facilidad. No seremos el mejor pero seremos capaces de hacer el trabajo. Obviamente habrá tareas en las que estemos muy lejos y seamos incapaces de hacer. Como una curva tipo campana. Esa es la forma de moverse más eficiente de moverse en este tipo de organizaciones.</p>	<p>we will be able to make the job. There would obviously be tasks far away of our competences that we won't be able to do. Like a bell curve. As one goes far from the high point the harder it gets to so things. It is the easier way to move in this kind of organizations.</p>
<p>El área donde yo estoy es técnica, por consiguiente las personas que están aquí tienen que tener habilidades técnicas para desarrollar su trabajo. Y te voy a contestar de una manera coyuntural de esta compañía ahora, la mayor dificultad para estos asuntos de flexibilidad es el cambio en el que esta envuelta esta compañía ahora. Hablo de aquí y no de alguna otra compañía. Esta compañía esta creciendo muchísimo en trafico, en infraestructura, en numero de cliente. Entonces una de las mayores dificultades que uno tiene en una situación de cambio como esa es adaptar unas mentalidades que nacieron para empresas pequeñas. Si tú trabajas en una empresa familiar pues ves el mundo de una cierta manera y tratas de resolver las cosas de una manera y cuando pasas de una empresa de 4 personas a una de 4000 pues las cosas cambian. Hay que ir a proceso mas estructurados y de verdad darse cuenta de que hay estamos en un barco de mayor tamaño y los barcos de mayor tamaño hay que gobernarlos de manera diferente. Aquí no se si conoces los inicios de esta compañía. Esta compañía viene de empresas pequeñitas en el norte del país que adquirió el holding. Algunas de las personas de esas compañías parece que no se han dado cuenta</p>	<p>The unit I am in is technical, so people working here must have technical skills to do their jobs. I am going to answer you thinking with this particular company in mind and right now: the main problem related to flexibility is the change in which the company is involved. I am talking about here and not other company. This company is growing very much in traffic, infrastructure, and number of clients. One of the difficulties one has in a change situation is to adapt "minds" or "ways of thinking" that were born for small companies. If you work in a family business or small enterprise you see things in a certain way and try to solve problems in a certain way. When you change from a 4 people company to a 400 people company things change. One must really realize that we are now in a big ship. And big ships must be governed differently.</p> <p>I don't know if you know the beginnings of this company. This company comes from several small companies in the north of the country that were acquired. Some people from those companies seem not to have noticed that they are not in those small companies anymore, that they are in a</p>

<p>de que ya no están en esas compañías sino en esta grande donde se hacen las cosas diferentes. Tampoco se han dado cuenta de que esta compañía ya no tiene 3 millones de clientes. Ya vamos en camino de tener 14 millones este año.</p> <p>Es como si creyeran que tienen 20 años y ya tienen 35 así que ya tienen que tener un comportamiento diferente. Eso esta pasando aquí por la velocidad del cambio. Es probablemente uno de los mayores problemas. La adaptación a gestionar una compañía que es mayor y por consiguiente tiene más distribuidores y más ventas. En mi caso mas cacharros que gestionar. No es lo mismo poner un aparato al mes que poner 50 al mes, no es lo mismo. Y no hacen falta 50 personas más, hacen falta menos pero hay que trabajar de una manera diferente.</p>	<p>holding and her we do things differently. They have not noticed either that we don't have 3 million clients anymore. We are about to reach 14 million clients this year.</p> <p>It is as if they believed they had 20 years when they have 35 so they must have a different behavior.</p> <p>This is happening here because of the speed of change. It is probably one of the biggest problems, the adaptability to manage a company that has grown and has more distributors and more sells. In my particular case, more "iron" to manage. It is not the same to put one equipment to work each month than putting 50. And it doesn't mean that 50 persons more a needed, less are needed but the work must be done differently.</p>
<p>la capacidad de adaptarse al cambio es inherente a las personas. Hay algunas que no se adaptan y otras que si. En lo que te platicaba, yo me estaba refiriendo a un tipo de cambio muy concreto que es el cambio en el volumen, en el tamaño de la compañía y en la velocidad. Si tu estas estudiando o planeas estudiar eso te lo vas a encontrar en muchas compañías celulares de mercados que todavía no están bien desarrollados. Las compañías fijas, sobre todo las de mercados muy grandes, están teniendo un cambio en la oferta del producto. Se dieron cuenta de que no tenían que vender un teléfono fijo solamente, sino una acceso a Internet, como de otra compañía. Eso se vende diferente, con</p>	<p>Adapting to change is inherent to humans. Some adapt more and some less. The change I talked about is a very specific change: change in volume, in the size of the company and in speed. Now that you are studying the topic, you will find this in many cellular companies in undeveloped markets.</p> <p>Fixed-service companies, especially those in well-developed markets are changing their products offer. They realized they should not sell only a telephone but an internet access as well. Like the product called X in other company. That is sold differently with different charging schemes. Fixed companies are older than cellular and</p>

<p>tarifas diferentes, con esquemas diferentes. Ese es el gran cambio de las compañías fijas. Las compañías fijas tienen mucho más tiempo que las celulares y claro han dejado de crecer a niveles muy rápidos.</p> <p>México es un caso especialmente diferente pues es un país muy grande con poca penetración y lo que está pasando es que está creciendo muy rápido. Somos compañías que están en expansión. Son países de índice de penetración normales, pero sin duda se llegará. En Europa la penetración es más alta, pero sin duda se llegará en México a niveles iguales. Al fin de cuentas es un producto destinado a la persona y las personas son iguales. Probablemente con un poder adquisitivo menor y se tarda más, pero llegará. Ya se están batiendo récords de penetración en algunos países que hace tiempo eran impensables. Por ejemplo Chile, que se pensaba que se llegaría al 40% y ahora van por el 60%-70%. Aquí vamos un poco más lento pero un país con un potencial como este es claro que llegará.</p>	<p>thus have stopped growing at high rates.</p> <p>Mexico is a special case because it is a big country with low penetration levels and it is growing very fast. We are companies in expansion. In Europe penetrations is higher, but eventually Mexico will reach such levels. At the end it is a product destined to people. And people are the same everywhere. Probably with lower income levels, but eventually they will reach the same levels. Penetration levels are making records that were thought as impossible. Chile for example, was seen as a country where the level World reaches 40% and it is now 60%-70%. Here we go slower, but the potential Mexico has make a no brainer that it will reach those high levels.</p>
<p>Yo creo que las diferencias no son tales como dicen los comerciales. Esta empresa no ha hecho un esfuerzo para unificar los productos. A mi me parece que las necesidades de un guatemalteco, chileno no son muy diferentes. Mira Mc Donald vende el mismo producto en todo el mundo: en Pekín, Moscú y NY. Vende con ligeras adaptaciones pero básicamente es el mismo. Es mucho más difícil vender comida pues la gente es más cuidadosa con lo que come que el negocio nuestro. Hay quienes</p>	<p>I think that differences are not so big as the people in the commercial unit think. This company has not made an effort to standardize the products offered. It seems to me that the needs of a Chilean, Guatemala or other are not significant. Mc Donald's for example, sells the same product everywhere, in Moscow, NY, Beijing, etc. they sell a product slightly different, but basically the same. It is far more difficult to sell food because people</p>

<p>dicen que cada mercado es diferente y que no es lo mismo. Para mi eso es rollo. Para mi no es difícil de estandarizar productos pues las necesidades de la gente son muy parecidas. Eso es mi opinión muy particular.</p> <p>Claro que eso aun no se ha conseguido. Yo que soy el responsable técnico de 5 países veo que la oferta comercial es diferente en cada uno. Uno vende en por segundos otros por paquetes de segundos. Fíjate que existe mucho más unión entre las diferentes operaciones regionales en las cosas técnicas que en las cosas comerciales. Y no tienen sentido. Donde podríamos tener más sinergias seria en la oferta comercial. Pues no nos engañemos los operadores usamos la misma tecnología. Este no es un negocio donde nos diferenciamos por la tecnología. Este es un negocio donde nos diferenciamos en como usamos la tecnología disponible. Ahí si. Es un negocio tecnológico por que esta soportado por cosas tecnológicas que varían muy rápidamente. Pero todos usamos más o menos lo mismo. Si tu analizaran la competencia descubrirías que usamos lo mismo que nuestro principal proveedor se llama Ericsson. Y sonaría mejor diciéndolo yo si te dijera que la tecnología nos diferencia, pero no. La diferencia es como la usamos, si somos eficientes o no somos eficientes. Podemos usar la tecnología que hay de forma poco eficiente y vamos a llegar retrasados, la calidad va a ser mala o lo podemos hacer bien. Pero la base es la misma. Por ejemplo, podemos hacer una comida y los productos o ingredientes que usa la competencia y</p>	<p>are more difficult with the things they eat than our product.</p> <p>Some people say that each market is different, for me that is "chit-chat" or just talk. For me it is not difficult to standardize products because needs are alike. That is my personal opinion.</p> <p>I am responsible of the technological deployment of 5 countries and so I know that the products are different. For example one sells by the minute, other by bundles or packages of minutes. We have more standardization in technical aspects than in commercials. That makes no sense. Where we could have more synergies is in the commercial aspects.</p> <p>Well, lets no fools us, the operators use the same technology.</p> <p>This is not a business where technology is a differentiator. It is a business where we differentiate from one another in the way we USE the technology. There we can make a difference. It is business where technology we use changes rapidly but every operator uses more or less the same tools. If you analyze our competitors you would find that we use the same technology and that our main equipment provider is Ericsson. It would sound good if I told you that Technology makes the difference but it doesn't. The difference is how we use it, if we are efficient or not. We can use the technology available not efficiently and we are going to provide a low quality service, we are going to be late, etc. or we can use</p>
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<p>nosotros son los mismos. No hay una salsa, verdura o carne especial que nosotros usemos.</p>	<p>it correctly and efficiently. Let make an analogy, if we were selling food, let's say that all our ingredients are the same; we do not have a special sauce or meet.</p>
<p>Aquí hay dos tipos de datos. Los datos de otras áreas que me importan a mí y los que yo tengo que les importan a otras áreas. Por ejemplo. Que datos de otras áreas nos importan a nosotros? Pues los que llamamos premisas comerciales. Cuando vamos a hacer el presupuesto nos sentamos con la gente de comercial y les decimos: oye cuanta gente vamos a tener, cuanto van a hablar y todo eso. Eso es lo que llamamos premisas comerciales. Sobre esa base es que nosotros diseñamos nuestra estrategia técnica. Si esa base falla pues obviamente nosotros fallamos. Este año ha pasado algo de eso. Ni mis compañeros de comercial se imaginaron lo que íbamos a crecer. Entonces cuando crecimos nos dimos cuenta que hacia falta infraestructura. Y que no se podía tener en un mes por que hay que hacer muchas cosas. Para mi esos datos son importantes.</p>	<p>Here we have two kinds of data. The data from other units that are important to me and the ones I have useful for them.</p> <p>For example, what data from other units are important to me? What we call commercial premises. When we are making our budget we sit with the commercial units to ask things such as: how many clients are we going to have? How many minutes are they going to use? And all that. That is what we call commercial premises.</p> <p>Based on that we plan our technological strategy. If those premises fail we are going to fail too. This year some of it has happened. Not even my colleagues from the commercial units imagined the levels of growth we would reach this year. So as we grew we realized that more infrastructure was needed and that it could not be deployed in a month because many steps had to be done. For me that data is important.</p>
<p>Una empresa pequeña y domestica pues tiene mucha flexibilidad pues no tiene que coordinar nada con nadie. Nosotros tenemos que coordinar la política tecnológica con el grupo holding. La política de suministros, de proveedores, de precios, etc. Todo eso se discute entre todos los operadores del grupo entonces yo no tengo ni debo tener una total libertad para salir y comprar esto y otro. Me</p>	<p>A small enterprise is very flexible because it must not coordinate its operations with anyone. We must coordinate or come to an agreement with the technological policies of the holding-group. The procurement, prices and providers policies among others. All this is discussed among all the operators that belong to the group. I do not have (and must not have) total freedom to go out and</p>

<p>dicen: usted debe comprar aquello que esta de acuerdo con las políticas de suministro de la Cía. De ahí se traen sinergias de diferentes naturalezas.</p>	<p>buy whatever equipment I want. They tell me: you must buy this, which is in accordance with the group's policies on procurement and provider.</p> <p>From there we make synergies of different natures.</p>
<p>las reglas deben de ser lo suficientemente flexibles para adaptarse a varios países. En ese sentido queda mucho por hacer. En este momento esta compañía trabaja de manera operativa. Es decir yo me adapto a las políticas tecnológicas del grupo y a cambio de eso tienen que escuchar cual es mi posición y que es lo que yo quiero. Lo que no se vale es que desde Madrid dicten: haga usted eso, yo diría: escúcheme usted a mi compañero y en base a eso tomamos una decisión". Así la decisión así es buena para todos y tiene lo menos malo para todos. Claro que esto depende de la compañía.</p>	<p>Rules must be flexible enough to be used by different countries. There is a long way to go in that sense. Right now I adapt to the technological policies and in return they must listen to my opinion and to what I want. What is not acceptable is that from Madrid comes an order saying, "do that". I would say "listen to me, and then we make a decision". That way the decision is the best or the less bad for everyone.</p>