Exploring Standardization and Integration in the Implementation of Industry Inter-Organizational Information Systems:

A Case Study in the Seaport of Barcelona

by

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Abstract

This dissertation presents an interpretive study of standardization and integration processes related to the implementation of an industry inter-organizational information system (IOIS) in the Seaport of Barcelona. This thesis adopts an ensemble view of the IOIS. First, from this perspective an IOIS is in constant flux as it is implemented and used in practice. Thus implementation becomes path dependent in the sense that existing systems influence the implementation choices and paths. Second, the implementation is being partly materially determined and partly socially constructed. That is, implementation may be viewed as socio-technical change processes that evolved around the implementation of the industry IOIS.

The objective of this thesis is to inquire into the socio-technical nature of IOIS implementation process and identify theoretical and practical issues that can provide a relevant explanation of the implementation dynamics. Based on an in-depth interpretive case study, which is combined with actor-network theory and grounded theory, I conduct an analysis of the implementation process and formalize a set of theoretical and practical implications. The first main theme of this work has been the standardization effort that has taken place before and during the implementation of the industry IOIS. The second main theme is related with the integration of the adopters' pre-existing systems with the industry IOIS.

The contributions that arise from this research have implications for research. Firstly, it adds to the limited but growing group of researchers that have focused on the processual and socio-technical nature of IOISs, as well as adds to the factor-based IOIS literature by detailing how and why some of these factors become important. Secondly, it contributes to longitudinal IS research by providing a deeper contextual understanding of the processes of adaptation and change that underlie IOIS implementation. Finally, it

contributes to IOIS standardization literature by establishing links between the process and stakeholder models.

On the other hand, this thesis has pragmatic legitimacy as it may serve as a helpful guide from which to improve practice. Firstly, this work confirms the dynamism of the stakes during the standardization process and highlights that the stakeholders that participate in the standardization have a range of stakes that vary among their nature and drive their attitude towards the process. Thus a continuous identification of participants' stakes appears to be very important. Secondly, this thesis shows that IOIS management has to place emphasis and devote resources not only to design, predict future conditions, and develop strategies and actions to meet those predictions, but also to pay attention and understand the unexpected events and emergent changes that arise during the use of the IOIS. Finally, IOIS implementation requires management to respond in order to reinforce or attenuate the emergent changes. That is, the IOIS management cannot only be conceived as predefined planned intervention, but also as a form of reaction and response to situational demands and others' behavior. In addition, this thesis provides a set of maneuvers that may guide managers and practitioners involved in the implementation of IOISs.

Preface

This dissertation is submitted as fulfillment of the requirements for the degree of Doctor in Management Sciences at the *Universitat Ramón Llull*.

The dissertation consists of six published papers. In addition, there are three introductory chapters that present the research problem, goals and questions, the philosophical premises and research methodology, and the background of the case study. Then three concluding chapters follow: one that presents the findings from the longitudinal case study, next a chapter that discusses the theoretical and practical contributions, and finally a chapter with the concluding remarks and venues for future research. The individual papers, listed below, are included as appendixes:

1. Rodon, J. (2006) "A Methodological and Conceptual Review of Inter-Organizational Information Systems Integration", accepted in the 14th European Conference on Information Systems, June 12-14, 2006, Göteborg

2. Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective", in IFIP International Federation for Information Processing, Volume 235, Organizational Dynamics of Technology-Based Innovation: Diversifying the Research Agenda, eds. McMaster, T., Wastell, D., Ferneley, E., and DeGross, J. (Boston: Springer), pp. 297-314.

3. Rodon, J., Ramis-Pujol, J. and Christiaanse, E (2007). "A Process-Stakeholder Analysis of B2B Industry Standardisation", *Journal of Enterprise Information Management*, 20 (1): 83-95

4. Rodon, J., and Pastor, J. A. (2007), "An Application of Grounded Theory to Study Managerial Action during the Implementation of an Inter-Organizational Information System", 6th European Conference on Research Methodology for Business and Management Studies, Lisbon.

5. Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Role of Emergent Strategies in Managing the Implementation of Industry IOIS", 67th Academy of Management Annual Meeting, Philadelphia.

6. Christiaanse, E., and Rodon, J. (2005) "A Multilevel Analysis of eHub Adoption and Consequences", *Electronic Markets*, 15 (4):355-364.

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1 Introduction

1.1 Research Problem

As a result of the steady pace of changes in the business environment, organizations are increasingly making use of information and communication technologies (ICT) to coordinate their business activities and transactions with those of their partners (Kumar et al. 1996). Hence ICT, which are supposed to reduce transaction costs (Malone et al. 1987) and remove inefficiencies from supply chains (Kumar 2001), are becoming ubiquitous and pervasive in the relations between firms (van Heck et al. 2007). Firms have two broad choices in using ICT to interact with partners. First, they can implement customized one-to-one integration with their partners' systems –the case of direct EDI links. Second, they can use an electronic intermediary to interact with trading partners (Kambil et al. 2002). Based on the ownership structure, the latter choice can be split into three scenarios: 1) private exchanges developed by a powerful player of an industry; 2) independent exchanges, which are developed by third parties that do not belong to the industry but mediate trading for the industry; and 3) industry inter-organizational information systems (IOIS) –the focus of this thesis–, in which a group of firms from an industry develop, control and support a common ICT infrastructure for trading.

The proliferation of any these technological infrastructures for trading, however, has left companies nursing a collection of largely incompatible information systems. The statement "if a company's systems are fragmented, its business is fragmented" (Davenport 1998, pp.123) shows that businesses at their core rely on integration of internal information systems not only to maintain consistent information, but also to avoid fragmentation of their organizational structures (i.e. having autonomous management of business units or multiple views of their customers). In the context of business networks, where many individual organizations combine their capabilities in order to compete effectively and respond more agile to changing

environments (van Heck et al. 2007), this idea of business fragmentation is also applicable. Accordingly, a real payoff from the use of an industry IOIS to support inter-organizational relations comes as the inter-firm processes and information systems are interconnected and integrated.

Information systems integration has become a businesses imperative (Waters 2005) which can generate value in terms of cost and time savings for businesses (Low 2002; Low 2004) or give them a distinct advantage (Iansiti et al. 2004), though when lacking can put the business at risk (Girard 2004). Even though some practitioners nowadays predict companies will increase the investment in integration technologies in the years to come (Biscotti et al. 2005; Rymer et al. 2005), systems integration has been a recurrent problem for practitioners as well as researchers in the last thirty years (Inmon 2000). Inter-firm systems integration –the integration of systems beyond the firm's organizational boundaries–, however, becomes more complex than internal systems integration since: 1) firms are autonomous entities that do not operate on data and processes shared between them thus there may be more syntactical and semantical conflicts (Park et al. 2004), 2) the number of stakeholders (humans and non-humans) involved is larger and there is a greater diversity of interests (Pouloudi et al. 1997), and 3) in inter-organizational contexts there is not always a higher authority that orchestrates the relationship (Markus 2000).

On the other hand, a prerequisite for the development of an industry IOIS and the further integration of the firms' information systems with the IOIS is the existence of shared meanings between the diverse systems, which relies on inter-company standards (Dai et al. 2002; El Sawy 2003). Once the standard is in place, firms can more easily integrate their systems with those of their partners. That is, standardization precedes integration. This thesis pays attention to the standards that enable organizations to exchange information. The dominant standards of inter-organizational data exchange are EDI standards (Chwelos et al. 2001; Damsgaard et al. 2000; Emmelhainz 1993), which have been used in the creation of IOISs in several

industries for many years (Damsgaard et al. 2001a; Hock-Hai et al. 1997). Several of these standardization initiatives have been undertaken by groups of firms of the same industry –forming a vertical industry consortium–, which collaborate in order to build the standard. Such standards are concerned more with the use of technology and with the semantics of information and business processes than with technology (Markus et al. 2006).

Although the study of IOISs started about 25 years ago (Barrett et al. 1982), there is still a shortage of knowledge and understanding of the whole implementation process of IOIS. This thesis attempts to provide a longitudinal and holistic view of the implementation process of an industry IOIS. In particular, I analyzed during four years two main activities of a twelve-year implementation process. These activities are: the development of the standard that underlies the IOIS (IOIS standardization), and the subsequent integration of the information systems of the diverse firms adopting the IOIS (IOIS integration). This thesis tries to deepen our understanding of the dynamics of industry IOIS implementation. The research presented here aims to identify theoretical as well as practical issues which can provide explanation of the observed dynamics. Based on an empirical case constructed over a longitudinal interpretive study in the Seaport of Barcelona, I conduct an analysis of the processes related to the implementation of an IOIS that supports the exchange of information between firms operating in the seaport, and formalize a set of theoretical and practical implications.

Before moving into the research purpose and questions, I will present the main concepts this thesis relies on: industry IOISs, IOIS implementation, standardization and integration.

1.2 Theoretical Concepts and Existing Research

1.2.1 Industry IOIS

The area of inter-organizational information systems emerged in the 80s (Barrett et al. 1982; Cash et al. 1985; Johnston et al. 1988). These authors, who view an IOIS as a strategic and productivity tool for companies, define an IOIS as "an automated information system shared by two or more companies" implemented for efficient exchange of business transactions (Cash et al. 1985, p.134). IOISs facilitate the exchange of information electronically across organizational boundaries and provide both processing capabilities and communication links. These studies view an IOIS as a computer and communication infrastructure and adopt a tool view (Orlikowski et al. 2001) of IOIS.

IOISs can be set up and controlled by individual companies, who establish direct links with their partners (Bakos 1991). This is the case of most of traditional EDI: "the direct computer-to-computer communication between an organization and its trading partners of business documents and information in a machine-readable, structured format that permits data to be processed by the receiver without rekeying." (Premkumar et al. 1997, p.108). In an alternative scenario, which is the focus of this thesis, a group of firms of a business sector or industry collaborate to setup up an industry IOIS (Damsgaard et al. 2001a; Hock-Hai et al. 1997; Kambil et al. 2002; van Baalen et al. 2000), which will be used by these firms and maybe others in the industry. With these industry IOISs, firms do not have to implement direct links with each of their partners; rather, they establish a unique link with the IOIS.

This thesis broads the tool view (Orlikowski et al. 2001) of IOIS to include not only the technical artifact but also other components –people, processes, standards, rules, interests, and so on. This view of an IOIS resembles an information infrastructure (Ciborra 2000; Hanseth et al. 1996; Monteiro et al. 1995; Star et al. 1996), which may be defined as an "evolving, shared,

open and heterogeneous installed base" (Hanseth 2000, p.60). Information infrastructures may be classified into: corporate (i.e. ERP systems), business sector (i.e. EDI networks) and universal (i.e. the Internet) (Hanseth et al. 2006b). Industry IOISs qualify as business sector information infrastructures, and as such an industry IOIS may be defined as a shared, evolving and heterogeneous installed base of ICT capabilities built on standardized interfaces. An IOIS is shared in the sense that it is set up, organized and used by firms in the same industry. It evolves as new companies integrate with it or as new types of exchanges and functionalities become available through the IOIS. An IOIS is not designed from scratch; the existing installed base has an inertia that influences the way the IOIS is designed (Monteiro 2000). It is heterogeneous as it encompasses multiple technologies as well as non-technological elements (social, organizational, institutional, etc.) that are necessary to sustain and operate the IOIS (Hanseth et al. 2006b). Finally, an IOIS usually embeds and supports a data and process standard, which defines the syntax, semantics and pragmatics of their transactions, and that is built by the same industry actors (Markus et al. 2006).

1.2.2 IOIS Implementation

Kwon and Zmud define the term implementation as "an organizational effort to diffuse an appropriate information technology within a user community." (Kwon et al. 1987, p.231). By looking at implementation from a technological diffusion perspective, which fits the proxy view of the ICT artifact (Orlikowski et al. 2001), these authors propose a process view for implementation that consists of six stages: initiation, adoption, adaptation, acceptance, routinization, and infusion (Cooper et al. 1990; Kwon et al. 1987). IS researchers usually consider that the last four stages –adaptation, acceptance, routinization, and infusion– are the core of IS implementation.

Literature on IOISs has widely imported and applied Cooper and Zmud's stage-model to IOIS implementation, but has rarely studied all the stages of the implementation process. Rather, it has focused on isolated moments of

the implementation stages: intent to adopt the IOIS (Chwelos et al. 2001), the adoption (Hart et al. 1997; Iacovou et al. 1995; Premkumar et al. 1997), the internal diffusion (Premkumar et al. 1994; Ramamurthy et al. 1999) and external diffusion (Massetti et al. 1996; Premkumar et al. 1994). Thus a holistic understanding of the IOIS implementation process is very limited.

In this thesis I will explore two main activities of the IOIS implementation process that occur along the six stages developed by Cooper et al. (1990). These activities are: 1) the development of a standard for the data structure, documents formats, and business processes of the industry; and 2) the integration of pre-existing systems that belong to industry members with the IOIS as well as the further use of the IOIS.

1.2.3 IOIS Standardization

Standards constitute a main component in our view of industry IOISs. Without standards, the diverse information systems that constitute the industry IOIS are just a collection of separate connections. Thus, for a successful deployment of any IOIS, firms have to "enforce IT architecture and standards" (Weill et al. 1998, p.266). In addition, the achievement of convergence in the data and processes across organizations requires a collaborative effort in the standard development (King et al. 2003).

Standardization is the "activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of the optimum degree of order in a given context" (ISO/IEC 1996). The output of this process is the standard, which may be defined as "a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context" (ISO/IEC 1996).

Theories from diverse fields have been used to study standards and standardization processes. Next we focus on economic and social theories.

First, economic theories have been widely applied for the study of standardization (Axelrod et al. 1995; Besen et al. 1994) because they are well suited to explain the possible outcomes of the standardization process and the consequences for involved organizations (Fomin et al. 2000). The concepts of network externalities[1], switching costs[2], lock-in effects[3], installed base and path dependence[4] have been widely analyzed by these studies.

From an economic perspective standardization has several social benefits: direct network externalities, indirect network effects, and compatibility. Direct network externalities appear when the "consumer's value for a good increases when another consumer has a compatible good" (Farrell et al. 1985, p. 70) as it is the case of cellular phones or electronic mail. There are indirect network effects that give rise to consumption externalities (Katz et al. 1985) when "a complementary good becomes cheaper and more readily available the greater the extent of the market" (Farrell et al. 1985, p. 71). For instance, externalities arise when the decision of an agent to buy a good, such as a personal computer, is concerned by the number of other agents who already have a similar personal computer because the amount of software and additional services provided depends on the number of personal computers being sold. Finally, the compatibility of products and services will enhance price competition among sellers (Farrell et al. 1985), which is good for the whole society although it may decrease profitability of companies. Companies participating in standardization may benefit from cost advantages, greater knowledge, and advantages from influencing the content of the standard (Swaan 2000). Likewise, standardization has some

[1] Network externalities describe a positive correlation between the number of users of a standard and its utility (Katz & Shapiro 1985). This starts demand side economies of scale. Due to the network externalities it will be desirable to choose an standard that is widely used by others.

[2] Companies are relatively free to choose between different configurations. But once they have invested in a particular standard they will find it increasingly expensive to switch to another (Swaan 2000).

[3] When there are network externalities and switching costs there is the risk that companies get lock into one system because the company is reluctant to switch to something better unless the rest do the same (Swaan 2000).

[4] Path dependence refers to a process of economic allocation such that the outcome of the process does not depend only on a priori determinants but on the specific history of the process.

important social costs: the reduction in the variety and incentives to innovate (Farrell et al. 1985).

On the other hand, Weiss (1993) argues that economists have been interested in why standards exist and how they come relevant, but have done little to address the process itself. This is where social theories play a role. There is a group of studies, which draw upon social theories, that conceptualize standardization as "heterogeneous engineering" meaning that it has to deal with technical as well as social aspects (Graham et al. 1995) and it results from a process of social interaction between stakeholders (Jakobs 2002). Contrary to economic theories, social-technical ones can help explain why the standardization process follows one or another course (Fomin et al. 2000) and provide a "processual account of the building of the socio-technical network related to the standardization actors" (Fomin et al. 2003, p.5). For instance, Hanseth and Monteiro (1997) use actor-network theory to analyze standardization of EDI messages within the health care sector and show how elements of the standard inscribe user behavior.

Within this socio-technical approach other studies have emphasized how stakeholders affect and impact the standardization. Jakobs et al. (2001) look at the motivations, attitudes, and views of people at the standardization committees (ISO, ITU and IETF) to explain how a particular standard emerges as well as its outcome. Their findings suggest that standardization committees are being dominated by the nuts and bolts of the process, requirements are unlikely to originate from users but from technical members of the committee, user participation in such committees is positive but a quite controversial issue, and cooperation is a must-be element for satisfactory standardization process outcome. Regarding the user participation, Jakobs (1998) states that although desirable, there is a need for mechanisms that align the heterogeneous user requirements during the process.

Another relevant aspect of the standardization process is the governance and coordination mechanisms. The standard may be seen as a collective

good for an industry, and the standardization as a social process of coordination of conflicts between different stakeholders' interests (Choh 1999). Otherwise without conflict the agreement will likely be rapid and easy (Farrell et al. 1988) and so coordination problems would not be relevant. These stakeholders may have different attitudes and interests which may lead to conflict during the standardization process. Faced with a coordination problem, standardization participants search for governance mechanisms that may solve the conflict. The literature discusses several alternatives to governance (see Table 1): committee, market, and hybrid approaches.

The committee approach to standard creation is being performed by standardization organizations such as ISO, IEC, IETF, IEEE, ITU or ANSI in order to develop public standards. Within this type of governance, participation usually is open to anyone (individual, organization, industry group or government agency), implementation is voluntary, and agreement is reached by consensus. These types of standards act as public infrastructure for innovation (Swaan 2000). The objective of a committee is to "avoid competition inter standards through the definition of a common proposal on which all actors of the market could agree" (Chiesa et al. 2002, p.426). However, this consensus principle may cause delay to the outcome because of the different wills of the participants, and so the chance for coordination would be missed (Farrell et al. 1988). "A pure committee system in which no one acts until agreement is reached is an equilibrium only if the players can commit themselves to it" (Farrell et al. 1988, p. 239).

An alternative approach is to let the market decide in favor of a proprietary standard that will win a position of market dominance. This is called *de facto* standard, and usually may result from research and development efforts by individual firms or cooperation between companies. The market approach to standardization "can sometimes achieve rapid and effective coordination" (Farrell et al. 1988, p. 236), producing then the bandwagon effect. However, when there is not a clear leader or there are different preferences among

standards (Farrell et al. 1988) then the bandwagon effect is imperfect. Some of the limitations of the market mechanism are: (1) it may cause collective interests to be dissolved into competition among private interests (Choh 1999); (2) the owner of the standard can develop undesirable monopoly (Swaan 2000); and (3) the dominant player has few incentives to standardize (Egyedi 2001).

A third hybrid approach to standardization governance is the consortium, which may be defined as an "alliance of firms and organizations, financed by membership fees, formed for the purpose of coordinating technology development and/or implementation activities, within discrete technological and/or product and services boundaries" (Hawkins 1998, p.1). Although different consortia have different objectives their "common objective is on coordinating a segment of the market" (Egyedi 2001, p. 13). The outcome of a consortium is the result of pragmatic consensus (Choh 1999). Within the consortium approach in the IS field we may distinguish between multi-industry or horizontal standards (i.e., EDIFACT, ebXML) and single-industry, domain-specific or vertical standards (i.e., CIDX, Mismo). The latter ones address the business problems to particular industries and concern more on the use of IT than on IT. Vertical industry standards extend beyond the technologies for exchanging data to encompass the semantics of the information, types of documents and data structures, and the underlying business processes and its pragmatics. Consortia are meant to be faster and less bureaucratic than committees (Egyedi 2001).

Both committees and consortia help mediate between different technologies and interests to impose a standard (Chiesa et al. 2002). Within the committee and consortia approaches there is also the option of legislative or regulatory bodies that legally enforce the standard (*de jure* standard). Formal standards emerge as superior than *de facto* ones in quality but take longer to produce (Swaan 2000).

Another characteristic that differentiates the governance mechanisms is the standardization timing. That's to say, the moment when it is preferable to

achieve a common standard definition, before (*ex ante*) or after (*ex post*) the introduction of the new standard on the market (Chiesa et al. 2002). With *ex ante* standardization only one standard arrives on the market and so the competition is limited to the boundaries of that standard, whereas with *ex post* different standards hit the market and probably there will be a standardization war to know which one will win (Chiesa et al. 2002).

	Committee	**Market**	**Consortium**
Property relations	Public standard	Proprietary standard	Industry quasi-public standard
Standard outcome	Formal standard / De jure standard	De facto standard	Formal standard / De jure standard
Scope	Single or multiple-industry, Global	Organization, Single or multiple-industry, Global	Vertical (single-industry) or horizontal (multi or cross-industry)
Agreement	Consensus		Consensus (less than committee)
Participation	Open / Democratic / Multi-party	Not open / Undemocratic / By a company or multi-party (collaboration)	Open (less) / Democratic (less) / Multi-party
Application of the standard	Regulatory or Voluntary	–	–
Timing	Ex ante	Ex post	Ex ante
Examples	ISO, IEC, IETF, IEEE, ANSI, UN/CEFACT	–	W3C, RosettaNet, papiNet, Mismo
Outcome standard	SGML, EDIFACT, ANSI X12	Windows, PDF	CIDX, xCBL, Mismo

Table 1: Governance mechanisms and standards

This paper studies the development of consortia-based standards that enable organizations exchange information. These standards concern the underlying inter-business processes –the pragmatics–, as well as the type of data exchanged and their syntax and semantics. The dominant form of inter-organizational data exchange is EDI standards –i.e. EDIFACT, ANSI X12–

, which are committee-based and are meant to lower transaction costs – coordination costs[5], operation risk[6] and opportunism risk[7] (Clemons et al. 1993)– and enable better communication among companies. Diverse industries have created consortia in order to adapt these EDI standards to their reality. The resulting consortia-based standards, however, are not neutral technical solutions but they reflect the specificities of business practices (Brousseau 1994). In addition, their development presents a dilemma: on one hand, standards try to fit the whole spectrum of exchange situations; on the other hand, such generality may restrict the particular and uniqueness needs of an industry (Wrigley et al. 1994).

1.2.4 IOIS Integration

The last concept studied in this thesis is IOIS integration. It refers to the integration of the diverse information systems that constitute the IOIS and that belong to different organizations. The first paper in the appendix (Rodon 2006) reviews existing literature on IOIS integration. Next I depict the main points of the paper to present the concept of IOIS integration.

IOIS integration has long been treated as a key IS research variable (Bensaou 1997; Zaheer et al. 1994). Researchers, however, have used a diversity of sometimes confusing terms such as enterprise application integration, application integration, systems integration, value chain integration, extended business integration and e-business integration to define the systems integration area (Themistocleous et al. 2002). On the other hand, the concept of systems integration has been attributed a diversity of meanings: integration as the interoperability of systems, as

[5] They are the costs that a firm has to faces when coordinating different units in the production of a product/service.

[6] Risk that the other parties in the transaction will fully misrepresent or underperform. "Operations risks stems from differences in objectives among the parties and is supported by information asymmetries between the parties" (Clemons et at. 1993, pp. 15).

[7] "…risks associated with a lack of bargaining power or the loss of bargaining power directly resulting from the execution of a relationship" (Clemons et at. 1993, pp. 16). The economics literature has examined three types of opportunism risks: relationship-specific investments, small number of potential suppliers for the product (small of bargaining) and loss of resource control.

building a whole new system, as combining existing systems into an overall whole (consolidation), as interconnecting or linking the systems for automated data exchange, as inter-organizational process reengineering, as standardizing existing systems (imposing uniformity), or as the adoption or diffusion of a system. Finally, different domains of the IS field (standardization, adoption, business process reengineering, ICT business value, mergers and acquisitions, etc.) or the operations field (supply chain management) have implicitly or explicitly tackled the concept of IOIS integration.

This diversity in IOIS integration research is manifested in the diversity of problems addressed (i.e. the measurement of the degree of integration, the study of the consequences or antecedents to integration), theories guiding the research (i.e. transaction cost, information processing, resource dependence) and research methodologies (i.e. quantitative, qualitative) used (Benbasat et al. 1996). Therefore, the concept of IOIS integration is ambiguous and lacks a common agreed definition and operationalization (Waring et al. 2000).

All these studies show that IOIS integration places several challenges. First, although firms invest in building new systems, the former ones do not always disappear over night; rather, they continue to coexist with the new ones. Most systems are integrated into an installed base of systems. This results into an heterogeneity of systems (Bussler 2003; Hasselbring 2000; Sheth et al. 1990), which becomes even more significant in inter-organizational contexts where systems belonging to different companies may be based on different non-compatible technologies, use different conceptual models to express business semantics, or support internal processes that are unique to the organizations that employ them. This heterogeneity is the source of conflict and side effects (Hanseth et al. 2006a).

Second, systems may be autonomous (Bussler 2003; Hasselbring 2000; Sheth et al. 1990) with respect to communication and operation, meaning that they may change their state without consulting the others with which

they are connected, or they must survive operation when they are occasionally disconnected. Moreover, distribution is a matter-of-fact when linking systems from dissimilar organizations. Systems are distributed since each maintains its own state and data separate from others (Bussler 2003; Hasselbring 2000; Sheth et al. 1990).

Finally, most of the strategies and mechanisms to IOIS integration include technical solutions such as messaging technologies (i.e. XML, EDI), data oriented technologies (i.e. data warehouses), transaction oriented technologies (i.e. application servers), and interface oriented technologies (i.e. adapters) (Bussler 2003; Linthicum 2001; Themistocleous et al. 2001; Themistocleous et al. 2002). But there is a lack of theoretical models or frameworks which view integration from a socio-technical perspective and explain the process by which IOIS integration occurs.

1.3 Research Position, Objective and Questions

The perspective adopted in this thesis is that IOISs are in constant flux as they are implemented and used in practice. Hence IOIS standardization and integration should be reckoned as a continuous, real-time process. In contrast to a large extent of prior research on IOIS implementation that has adopted tool and proxy views (Orlikowski et al. 2001) of the IOIS and has proposed factor models (Iacovou et al. 1995; Zaheer et al. 1994), this thesis looks at the IOIS from an ensemble view –in particular the variant called technology as development project– (Orlikowski et al. 2001) and adopts a process approach (Langley 1999; Markus et al. 1988). Firstly, implementation does not come quickly to information systems, which have been built up over years by layering new generations of technology or data models on top of old ones. IOIS implementation therefore becomes path dependent in the sense that existing systems will influence the integration choices and paths. Separate information systems become integrated over time into complex ensembles of heterogeneous ICT artifacts, which are increasingly connected with and dependent upon one another (Hanseth et

al. 2006b). Secondly, this thesis views implementation as being partly materially determined and partly socially constructed. When applying such a perspective the: "[…] information technology is more than just the tools deployed on the desktop or on the factory floor. It is the ensemble or 'web' of equipment, techniques, applications, and people that define a social context, including the history of commitments in making up that web, the infrastructure that supports its development and use, and the social relations and processes that make up the terrain in which people use it." (Orlikowski et al. 2001, p.122). This socio-technical perspective leads me to argue that IOIS implementation is simultaneously a technological and social phenomenon. IOIS implementation depends on the technical artifacts as well as on the social negotiation processes between stakeholders. Thirdly, implementation is performed on a social level, as the activities undertaken by people in organizations, serve to glue artifacts and people together in the working practice. The multiple interests and viewpoints of the stakeholders, the way these interests and viewpoints evolve, as well as how the stakeholders are interrelated (Pouloudi et al. 1997), shape the implementation process.

Therefore, *the objective of this thesis is to inquire into the socio-technical nature of the IOIS implementation process*. The thesis aims to contribute to a deeper understanding of the process by which industry IOISs are implemented, to open the black box of IOISs with respect to the context and process of their implementation and use (Orlikowski et al. 2001), as well as to open up new directions for research and practice. To fulfill this objective I study two main constituents of IOIS implementation: IOIS standardization and integration. This research objective can be captured by the following research questions:

- How IOIS implementation unfolds over time?
- How do the socio-technical actors interact throughout the implementation process?
- How can the implementation process be managed?

These research questions stress my concern with describing, exploring and analyzing IOIS implementation in a specific context. The definition of the research objective and questions has not proceeded through a linear sequence consisting of: 1) reviewing existing literature, and 2) defining the research problem (questions and objective). Rather, I have conducted some empirical research (Rodon 2003; Rodon et al. 2005; Rodon et al. 2004) in parallel with literature review (Rodon 2006). Both tasks have focused on the study of IOIS standardization, implementation and integration. As I was not able to explain the longevity of the implementation process only from a techno-economical perspective, my theoretical purpose became, since an early stage, to frame the topic of IOIS implementation from a socio-technical perspective. My encounter with existing literature (the underlying theories used, the type of theory being developed, and the research problem) and my empirical work also drove my research questions. Therefore, this thesis is the outcome of the interplay between these three components: the existing theories and studies, the empirical studies I conducted, and the research problem (see Figure 1).

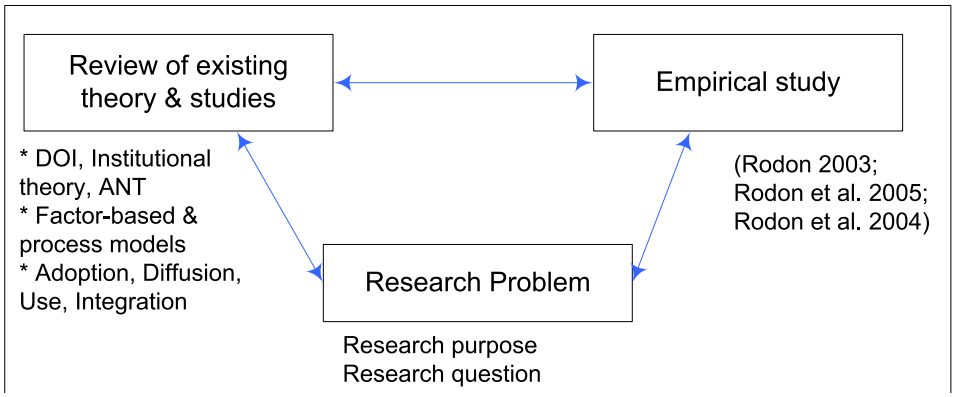


Figure 1: The research process as an interplay of three components

1.4 Outline of the thesis

Besides the present one, this thesis includes 6 chapters with the following content. Chapter 2 illustrates the methodological and epistemological approach of the thesis. In chapter 3 I present the background of the case

study and describe the data collection process. The empirical data and theoretical discussion related to industry IOIS implementation are presented in six papers attached as appendixes. Then chapter 4 discusses the research findings by providing abstracts of the papers and summarizing the findings in a preliminary analysis. The thesis follows with the discussion of the theoretical and practical contributions of the findings. Finally, the concluding remarks are presented as well as the lines for future research.

2 Research Approach

This chapter opens up by justifying the epistemology adopted in this thesis, next I describe the research method applied, the theoretical framework used, the theoretical formulation and timeframe of the study, and finally I describe the data collection method and process.

2.1 Underlying Epistemology

Epistemology concerns the assumption about knowledge and how can it be obtained. Burrell and Morgan (1979) identify two extreme positions: positivism and anti-positivism. Positivists believe they can find regularities and causal relations that predict a phenomenon, and can generate objective knowledge of social reality; they believe one can develop hypotheses and test them, and that knowledge is a cumulative process. Walsham (1993) refers to positivist research as based on the view that the world exhibits objective cause-effect relationships that can be discovered, at least partially, by structured observation. Klein and Myers (1999) state that "research can be classified as positivist if there is evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from a representative sample to a stated population" (p. 69).

On the other hand, anti-positivists reject the existence of regularities in social reality; they regard all knowledge of social phenomenon as subjective. Within the anti-positivism there is the interpretive research (Orlikowski et al. 1991), which assumes people create and associate their own subjective and inter-subjective meanings as they interact with the world around them. Interpretive research rejects the possibility of an objective or factual account of events and situations. It asserts that reality is a construct that people apply, and that social phenomenon cannot be examined independently of the individuals contributing to that reality. It also suggests that researchers themselves cannot be totally objective. It is from the researcher's conceptual

orientation that the research questions, interpretations and explanations flow. Interpretative research emphasizes the context of the research and specifies the need for critical reflections on social and historical background of the research setting (Galliers 1987; Galliers 1993). IS research may be regarded as interpretive "if it is assumed that our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools, and other artifacts" (Klein et al. 1999, p.69). Within IS research interpretive approaches acknowledge that, although information systems have a strong technological component, they are implemented and used by people operating in a social context.

In contrast to a research approach where from the outset one has a model consisting of a set of relationships among constructs and several propositions, this thesis explores one central construct –IOIS implementation-. First, there are clearly epistemological limits to understanding IOIS implementation, because of its complexity, which is partly materially determined and partly socially constructed. On the other hand, although the partial outcomes of implementation may be somehow observable and explained, they are context-specific. Therefore, owing to the state-of-the art in implementation research and my interest in generating new insights relative to the existing literature, I refused a purely deductive, hypothesis-testing approach.

The reason for adopting an interpretive approach lies in the exploratory nature of the research questions and in the objective of providing understanding over the evolution of IOIS implementation. Moreover, the purpose of this study stresses my concern with describing and analyzing the process of IOIS implementation, rather than explaining it through cause-effect relations between a set of constructs. This thesis views IOISs as social-technical systems, where the dichotomy between social context and technical artifacts dissolves in the complex intertwining of socio-technical actors (Latour 1987). Moreover, the research aims at studying how the IOIS is being implemented in a given context and how the context shapes and is

changed by the IOIS. For this reason, a qualitative methodology, in the form of interpretive in-depth case study, appeared the most fruitful (Strauss et al. 1998; Walsham 1995b; Walsham 2006).

2.2 Qualitative Research Methods and Theoretical Framework

"A research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection" (Myers 1997). Our choice of research methods were driven by several factors: the research problem, the context to be investigated, and the existing research. From the diverse types of interpretive research methods this thesis combines case study (Walsham 1995b) with grounded theory (Glaser et al. 1967; Strauss et al. 1998). On the other hand, I used actor-network theory (Callon 1986; Latour 1987; Latour 1999; Law 1992) as the interpretive framework of analysis in one of the papers (Rodon et al. 2007b). This framework as well as the research methods has been useful in developing context-based, process-oriented descriptions and explanations of a phenomenon such IOIS implementation. Although I develop and justify the use of each of the methods in each paper (see Appendixes), next I briefly present each method.

2.2.1 Case Study

A case study may involve a detailed study of a single organization (single case study) or group of organizations (multiple case studies). Case studies explore, describe, or explain in detail a particular issue within a unit of study (Benbasat et al. 1987; Yin 2003). The data from case studies are useful for their qualitative richness normally obtained in a complex and real world situation (Benbasat et al. 1987; Yin 2003). A case study involves the detailed examination of a single setting or a particular event, and its main concern is with detail and complexity of the case; it provides explanation of the phenomenon studied because it allows for a "thick description" (Miles et al. 1994). Accordingly, a case study allows me to investigate a contemporary phenomenon, such as IOIS implementation, within its real-life context,

where boundaries between the phenomenon and the context are not clearly evident, and in which multiple sources of evidence (i.e. interviews, documents, observations) are used (Benbasat et al. 1987; Yin 2003). Moreover, case study research approach enables an understanding of the nature and complexity of the processes occurring, by answering how and why questions. Case studies allow researchers to "retain the holistic and meaningful characteristics of real-life events" (Yin 2003, p.14) such as IS implementation processes. This is in line with an aim of this research: construct a theoretical and practical understanding of the phenomenon in its complexity within a holistic perspective.

Regarding the type of theory being developed, case studies can be classified as: explanatory, exploratory, and descriptive (Yin 2003). In the explanatory case study the researcher looks for cause-effect relationships, thus theory serves as an initial guide to design and data collection. In an exploratory case study data collection occurs before any specific research question or model is formulated; thus theory is a final product of the research. Finally, in descriptive case studies theory is used as part of an iterative process of data collection and analysis. This thesis presents an exploratory and descriptive case study.

On the other hand, case studies can be both interpretive (Walsham 1995b) and positivist (Yin 2003). This thesis is grounded in the interpretive approach to case study (Walsham 1995b; Walsham 2006), which is "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context." (Walsham 1993, p. 14). A basic assumption in the interpretive case study approach is that the implementation process is not determined by any single factor alone.

In this thesis I use several sources of data: internal documentation from participants, archival records from working groups and press, interviews, direct and participant observation, and mailing lists. However, the primary source of data has been semi structured in-depth interviews, which are

reckoned to be the method that provides the researcher the "best access [to] the interpretations that participants have regarding the actions and events which have or are taking place." (Walsham 1995b, p. 78).

Finally, regarding the problem of generalization in interpretive research, Walsham (1995b) identifies four different ways to make generalization based on interpretive case studies: 1) the development of new concepts, 2) the generation of theory, 3) the drawing of specific implications, and 4) the contribution of rich insight. That is, interpretive case studies' goal is not statistical generalization: "If one adopts a positivistic epistemological stance, then statistical generalizability is a key goal. However, from an interpretive position, the validity and extrapolation from an individual case or cases depends not on the representativeness of such cases in a statistical sense, but on the plausibility and cogency of the logical reasoning applied in describing and presenting the results from the cases and in drawing conclusions from them" (Walsham 1993, p. 15).

2.2.2 Grounded Theory

Grounded theory is an interpretive mode of enquiry that seeks to develop theory that is grounded in data systematically gathered and analyzed. Grounded Theory can be traced to the seminal work of Glaser and Strauss (1967), "The Discovery of Grounded Theory". In this book both authors were critical of what they perceived to be a way of research that drew upon an existing "grand theory" (Mills 1959), and that was satisfied with testing hypotheses build on this underlying theory. In contrast to this hypothetic-deductive approach, grounded theory starts with observations, which are made not to test existing theories, but to discover and generate theories that are as close as possible to the reality observed.

Grounded theory has its roots in symbolic interactionism (Blumer 1969). Symbolic interactionism set out three basic premises: 1) "Human beings act toward things on the basis of the meanings that the things have for them."; 2) "The meaning of such things is derived from, or arises out of, the social

interaction that one has with one's fellows."; and 3) "These meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters" (Blumer 1969).

While there are no major differences between Glaser and Strauss views towards key elements like theoretical sampling and constant comparison, the two founders of grounded theory took somewhat different paths. Strauss proceeded to refine the technique of coding by incorporating more analytical techniques, and attached a more active role to the researcher (Strauss et al. 1990). Glaser, on the other hand, argued that rather than putting more emphasis on methods and forcing structure onto data, the researcher should take a passive stance free from preconceptions, trusting that theory will emerge (Glaser 1992).

Grounded theory helped me focus on the contextual, processual and temporal nature of the implementation, as well as on human agency –the actions that managers of the IOIS perform to manage the implementation. Although the use of coding procedures have a positivist feel, the process of constant comparision, making sense of and structuring data was very interpretive in nature (Rodon et al. 2007a). I used grounded theory on two of the papers. In the first of these papers (Rodon et al. 2007d), I decided to use seed categories (Miles et al. 1994) to help guide the research. In the second of these papers (Rodon et al. 2007c), I favored the "Straussian" version over the "Glaserian" one. I followed the "Straussian" version in the sense that I drew upon previous knowledge about the research problem that was developed in the review of existing research (Rodon 2006), as well as I use Strauss coding paradigm (Strauss et al. 1990). I devoted a paper (Rodon et al. 2007a) to explain and justify this second paper. In short, I combined case study and grounded theory to provide new insights grounded in empirical observations (Rodon et al. 2007c; Rodon et al. 2007d).

2.2.3 Theoretical Framework: Actor-network Theory

Based on the researcher's belief about the identity of the causal agent (Markus et al. 1988), there are two opposite positions in explaining IS implementation. At one extreme there is technical determinism, which considers that technology causes changes in society. It focuses on the technological aspects of the implementation process, and treats the social as the context in which the implementation takes place. At the other extreme there is social determinism, which holds that the social interactions can be used to explain technological change. That is, technology is shaped by social factors. In the middle, there is Actor-Network Theory (ANT), which considers that the "symbolic boundary between people and information technology is in a constant state of flux across a wide spectrum of contemporary work and leisure activities" (Walsham 1997, p.467). ANT considers both technical and social determinism to be flawed and proposes a socio-technical account (Callon 1986; Latour 1987) in which neither the social nor the technical positions are privileged. Rather, ANT emphasizes the interrelated character of social and technical actors and suggests the notion of heterogeneity of actors and the need to treat –from an analytical stance– both human and non-human actors in the same way. ANT is based on three principles: agnosticism, general symmetry and free association (Callon 1986). The first of these tenets, agnosticism, means that analytical impartiality is demanded towards all the actors involved in the phenomenon under consideration, whether they are human or non-human. Second, ANT assumes symmetry between the technical and the social worlds, which means that rules of method applied in one domain, may operate exactly the same in the other. Neither the social nor the technical elements in these heterogeneous networks should be given any special explanatory status. Finally, the tenet of free association requires the elimination and abandonment of all a priori distinctions between the technical and the social: "ANT was developed to analyse situations in which it is difficult to separate humans and non-humans, and in which the actors have variable forms and competencies" (Callon 1999, p.183).

Owing to the fact that ANT treats technology, processes, rules, etc. as another actor, it is a suitable theoretical framework to analyze how people and technologies interact. As Orlikowski et al. (2001) argue "…adequate accounts of technological change [the case of IOIS implementation] require hybrid explanations that weave together human action and choice, the functions and features of specific technologies, and the contexts of a technology's use in a way that attends to the micro-dynamics of situated practice" (Orlikowski et al. 2001, p.150-151).

In the last decade a growing number of IS studies have drawn upon ANT to study: information infrastructures standards (Hanseth et al. 1996), the historical evolution of EDI (Hanseth et al. 1997), the development and use of geographical information systems in district-level administration in India (Walsham et al. 1999), the development of corporate information infrastructures (Ciborra 2000), and ICT project escalation (Mähring et al. 2004).

The conceptualization of an industry IOIS in this thesis explicitly draws upon ANT, because the implementation of an industry IOIS is a process that unfolds over time, in which there are complex interactions between human and non-human actors that mutually interact and shape the IOIS. Moreover, I use ANT to emphasize the socio-technical nature and longevity of IOIS implementation, as well as to track the processes whereby actors are aligned and organized into a stable actor, the IOIS.

ANT has no unique set of methods with which it is associated, but makes use of many of the same techniques such as case study. The main advice on method suggested by the proponents of ANT is to follow the actors (Callon 1986; Callon 1991) and to let them set the limits of the study. In this thesis I use ANT as an analytical tool or a "sensitizing device" (Klein et al. 1999) to view the world in a certain way. Accordingly, I adopt ANT as a vocabulary and lens to interpret the complexity of the dynamics associated with IOIS implementation.

2.3 Theoretical Formulation and Timeframe of the Study

Based on the logical formulation of a theoretical argument, Markus and Robey (1988) distinguish between variance and process theories. Variance theories provide explanation for phenomena in terms of relationships between independent and dependent variables, and in which the outcome will occur when necessary conditions are present. In contrast, process theories provide explanations in terms of sequence of events, activities and choices leading to an outcome. Process theories assert that the outcome may occur under certain conditions, but also that outcomes may not occur when conditions are present (Markus et al. 1988; Mohr 1982). Process theories offer an explanation of temporal order in which a discrete set of events occurred (Gregor 2006). In a review of process models proposed in the strategic management literature, Van de Ven presents three meanings of process (Van de Ven 1992). Firstly, a process may be conceptualized as a logic that explains a causal relationship between independent and dependent variables. Secondly, a process may be conceptualized as a category of concepts of individual or organizational actions. Process concepts are operationalized as constructs, and measured as variables, the attributes of which can vary along numerical scales. Thirdly, a process may be conceptualized as a sequence of events that describes how things change over time. This thesis adopts this third meaning by focusing on the sequences of incidents, activities and stages that unfold over the duration of IOIS implementation.

On the other hand, Walsham (1995a) identifies three distinct roles of theories in interpretive research: 1) as an initial guide to design and data collection; 2) as part of an iterative process of data collection and analysis; and 3) as a final product of the research. The thesis is restricted to field exploration and theory building, thus second and third roles in Walsham's classification. Specifically, it concerns with discovering process, not in the sense of stages or phases that follow a specific temporal order, but in the sense of chains of changes in the patterns of action between actors and in

the context for those actions. This is in line with Van de Ven and Huber (1990) who argue that research questions which seek to examining organizational change over time –the case of IOIS implementation–, require a framework which can explain the unfolding temporal processes of change. They note that: "Process studies are fundamental to gaining an appreciation of dynamic organizational life, and to developing and testing theories of organizational adoption, change, innovation, and redesign." (Van de Ven et al. 1990, p.213). Many fields of inquiry have employed longitudinal research to study change and adaptation. For instance, Pettigrew (1985) supports the need for a longitudinal study in the following statement: "The data collection requires methods and frames sensitive to alternative antecedent (previous) conditions, variety of receiving culture for change, alternative levels of analysis and explanation, different strategies, and alternative outcomes. Above all it requires time series, processual data in order to see how and why the three analytic factors (context, process, content) work themselves through any particular sequence of events and actions…Without longitudinal data it is impossible to identify the processual dynamics of changing, the relationship between forces of continuity and change, and therefore the inextricable link between structure and process." (Pettigrew 1985, p.64).

An IOIS is dynamic in development, use, impact, etc., which occur within complex inter-organizational and human systems. Longitudinal research, which denotes the investigations of processes over time, allows the chronicling of events during IOIS implementation (Pettigrew 1985). Accordingly, studying interconnected and dynamic processes inherent in the implementation of the IOIS requires a longitudinal data set (Langley 1999; Markus et al. 1988; Miles et al. 1994). I develop a case study that focuses on the implementation process of an IOIS, and tracks different units of analysis (people, companies, dyads, systems, standards, and so on). The resulting process-type theory from this thesis will explain how and why a phenomenon occurs (Gregor 2006). Making predictions about the phenomenon will not be a major concern. Likewise, the statistical

generalization from the results I obtain and the replication of this field study goes beyond the scope of this research. From the rich description of a longitudinal case, I will generalize to theoretical and practical implications, and to rich insights (Walsham 1995b).

2.4 Data Collection

I conducted a longitudinal case study about the implementation of an industry IOIS in the Seaport of Barcelona. Given the longitudinal nature of the study it has involved observations of the same phenomenon over several periods of time. The empirical work was carried out over three different periods between 2001 and 2005 (see Table 2). The primary data collection method was semi structured interviews, and the data I gathered were mostly unstructured and qualitative. The interviews typically lasted between 1 hour and 1 hour and a half. These interviews were carried out using a set of open-ended questions that were organized into questionnaires. Interviews were recorded, and immediately transcribed and analyzed. The outcome of the analysis of an interview formed the basis of subsequent interviews. Most of the empirical data were collected and analyzed in an iterative way (Strauss et al. 1998). I collected data related to adoption decision, implementation barriers, system use, system, process and data changes, and related events during the implementation process. Non-human actors were 'interviewed' firstly by asking humans about them, secondly by collecting written material in the form of technical notes, and magazine articles.

In the first period (October-November 2001) I conducted 6 interviews aiming at becoming familiar with the port community context, the historical reasons for implementing the IOIS, the actors involved, and some of the major events. I also used a lot of secondary sources of data: internal documents of the Port Authority, the diverse trade associations, and press articles. I gathered retrospective data concerning the period 1992 to 2001.

During the second period (January-March 2004) I conducted 15 interviews aiming at understanding the nature of the standardization process that was

taking place. Data collection and analysis focused on the process of standard development and the role of stakeholders in the process. In this period I also participated (passive participation) in meetings of the different workgroups of the standardization committee. The rich insights I got from participating in the meetings complemented data collected from interviews, standard documents, meeting minutes, and press articles. The type of events I studied in this phase compromised the period 1998 to 2004.

Finally, in the third period (March-November 2005) I conducted 27 interviews and inquired about the problems companies were facing when they integrated their systems with the IOIS and when they used it. Likewise, in between these three periods I have continuously analyzed data related with the development of the IOIS and the standard coming from mailing lists and press articles. A detailed description of the process of data collection and analysis in this third period can be found in the fourth paper of the appendixes (Rodon et al. 2007a).

A total of 48 interviews were conducted with informants such as CEOs, IS managers and developers, operations managers, marketing managers, consultants and final users of the IOIS. Interviews were indistinctly done in Spanish and Catalan. Other sources of data have been: passive field observation, meeting attendance, meeting minutes, internal company documents, mailing lists, and press articles. The data collection method across various sources was chosen because it is particularly useful in theory generation since it provides multiple perspectives on the case under investigation (Eisenhardt 1989).

Period	Interviews, Topics and Periods Inquired	Informants
1st (Oct.-Nov. 2001)	Number of interviews: 6 Topics: History of the standardization process and the decision to implement the IOIS, and the	PAB[8]: CIO and IS workers IGC[9] and TelFor[10]: participants

[8] PAB: Port Authority of Barcelona

[9] IGC: Information Guarantee Commission

	actors involved Period inquired: 1992-2001	IOIS CEO and CIO Two adopters of the IOIS: CEOs and CIOs
2nd (Jan.-March 2004)	Number of interviews: 15 Topics: Standard development; Standardization organization, outcomes and actors. Period inquired: 1998-2004	TelFor: six participants PAB: CIO and two IS workers Customs: two managers
3rd (March-Nov. 2005)	Number of interviews: 27 Topics: Standard evolution and outcomes; IOIS implementation (design decisions and actions and adopters actions); Problems that arise during the integration of pre-existing systems with the IOIS Period inquired: 2000-2005	IOIS: CEO, Marketing manager, IS consultants and designers 9 port agents: CEOs, COOs, CIOs, Developers and Users

Table 2: Data collection period, interviews conducted, topic being inquired and informants

Since the goal is studying IOIS standardization and integration, the primary unit of analysis has been the business network formed by the firms participating in the standardization and integrating their systems with the IOIS. This unit of analysis can be split into several levels: 1) the individuals involved in the process; 2) the individual firms; 3) the vertical and horizontal transaction relationships between firms in the business network; 4) the remote environment (i.e. other industries); and 5) the IOIS and the integration mechanisms and the underlying technologies (i.e. XML, email, ftp).

Finally, during this study I adopted the role of the involved researcher (Walsham 1995b). That is, besides attending meetings and presentations, I provided feedback to participants –in the form of presentations and reports after each of the three data gathering periods. I consider this feedback was useful because: 1) it gave me an in-depth understanding of the phenomenon;

[10] TelFor: Telematic Forum

2) it was a way to contrast and validate my interpretation; and 3) it facilitated my subsequent access to the field.

3 The Case Study Background

3.1 Seaports and Industry IOISs

This thesis focuses on the context of seaport communities. Seaports, as the core of a country's supply chain[11], aid the exchange of products and services between the different individual supply chains, and consequently play a very important role in the competitiveness of a country (Bagchi et al. 2001). Faced with the growth of the international transport trade (UNCTAD 2004), and in order to preserve their role as a factor of competitiveness, ports have long invested in the expansion and improvement of the facilities and services they offer, the establishment of better connections with their hinterlands[12], through the construction of new roads, railway lines, etc., the conservation and improvement of the environment, and the application of ICT to increase the efficiency of the link between supply chains. Likewise, the progress in international trade in ports has depended on standards like EDI, which define the documentary structures and protocols (Wrigley et al. 1994).

Broadly speaking, the logistic chain for the maritime transport of goods between the country of origin and destination follows the sequence of events set forth in Figure 2. First, the goods in the hands of a shipper are collected by an inland mode of transport that takes them to the loading terminal of the port of origin. Once there, the goods are unloaded from this inland mode of transport and loaded onto the vessel that will transport them to the port of destination. Finally, when the vessel reaches the destination port it docks in the loading terminal, where the goods are unloaded and transported to the consignee.

[11] A country's supply chain can be seen as all the individual supply chains of the various industries, working jointly to efficiently manage the flow of raw materials, components, finished products and associated information from their origin to their final destination.

[12] The hinterland of a port is its area of influence.

Within the context of this sequence of activities, a port is an area in which the goods change their mode of transport. They enter by sea and leave by land (import), or they arrive by land and leave by sea (export), or they arrive and leave by sea (transshipment). Accordingly, a seaport is an interface between sea transportation system on one side, and the land transport network on the other side. Traditionally much of the port operational and management practices have developed around the seashore interface, rather than the landside operations (UNCTAD 2004). Whereas the shipping industry has developed standard procedures for the seashore interface, the development of land transport has been shaped by the local regulatory and organizational framework.

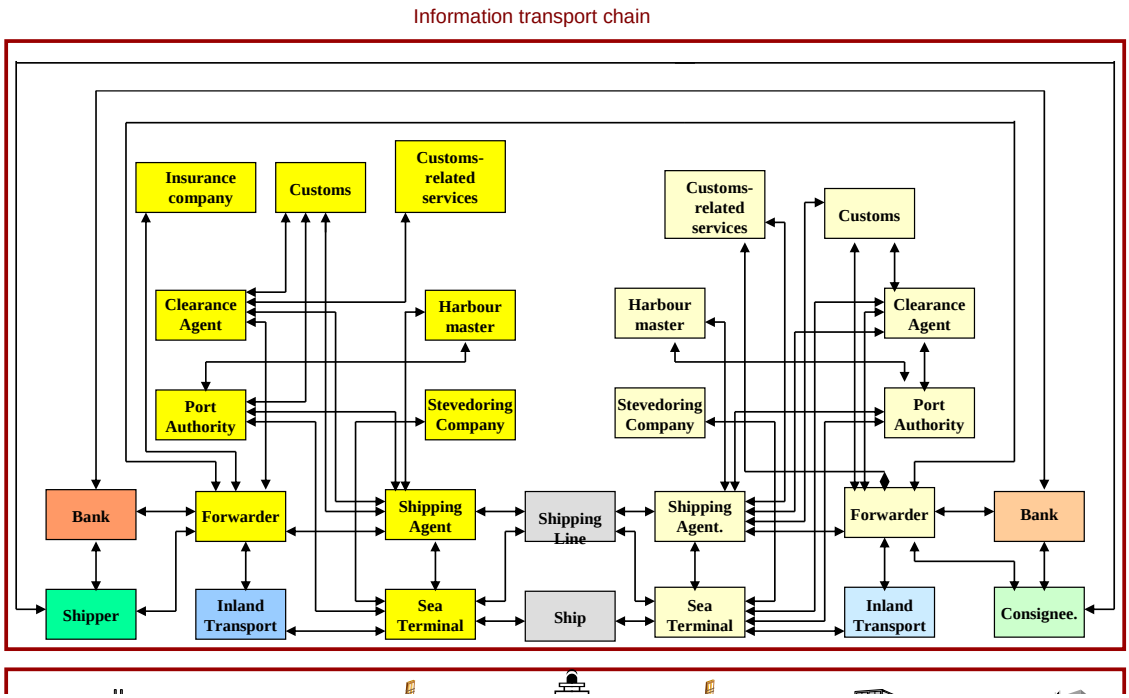


Figure 2: Maritime transport chain

In the landside transport network, companies operate in different roles varying from: port authority, shipping agents, terminal operators, stevedores, harbor master, freight forwarders, customs, haulers and rail carriers, pilots,

clearing agents, etc (see Table 3 for a description of these roles). These organizations form a transport network that allows them to interact and co-operate with the aim of carrying out the physical tasks involved in moving the goods and the administrative tasks related to the execution of the service order made by the client (shipper/consignee). Thus there are two forms of interactions in the transport network: 1) operational interactions related with the physical transfer of cargo (physical transport chain in Figure 2), and 2) administrative interactions related with the supervisory and information based exchanges (information transport chain in Figure 2). Each member in the transport network operates as a supplier as well as a customer, and generates some kind of information that is to be transferred along the network (van Baalen et al. 2000).

It can thus be seen that the port's internal administrative circuits form a complex system, in which each organization requires certain information and in turn generates new information, and moreover each one has specific responsibilities and interests. These organizations are of very different types, with different structures and motivations. Thus, for example, shipping and forwarding agents are private profit-making bodies, while others, such as the Port Authority, Customs, or the Health inspection organizations dependent on the state authorities, are non-profit-making and base their organizations on the legislative provisions of the central government.

Port Agent	Description
Port Authority of Barcelona (PAB)	A state agency with its own legal personality and independent management. It is in charge of the management and operation of the Port of Barcelona. It has been assigned several tasks relating to the control, management and administration of port services; co-ordination of the action of the government bodies that act in the Port of Barcelona; arrangement and control of the Port's service area; planning, construction, conservation and operation of the port works and services; commercial promotion of the port activity; application and collection of the tariffs for the services it provides; and granting of concessions, authorizations and signing of service provision agreements within the sphere of the port. The PAB intervenes in a large part of the processes related to the port activity in tasks of supervision and control of the physical actions, both the handling of goods and the movement of vessels, as it co-ordinates all the arrivals and departures of vessels, safety in the port and of the goods,

	inspections performed on the cargo, concessions, the performance of services complementing the loading and unloading, etc. For all this to be possible it is essential for the PAB to have reliable information regarding the situation and real state of the port, that is to say, knowledge of the position of the goods, and the arrivals and departures of the vessels.
Customs	As an organization dependent on the Treasury, the Customs and Special Tax Section (State Tax Administration Agency) is in charge of the customs office. It is the administration entrusted with supervising the arrival and departure of products in the country and of collecting the duties and taxes on goods traffic. It has the authority to perform physical inspections of goods, a power that it does not always exert as, in most cases, a mere documentary inspection (administrative procedure) will be sufficient before clearing the goods.
Shipping agent	The shipping agent acts as an independent intermediary on behalf and on account of the shipping company. It has various duties assigned to it such as the provision of services to the vessel and its crew, the completion, on account of the ship-owner, of the administrative formalities during the vessel's stay in the port, and a series of duties related to the goods that the vessel transports and their documentation. From the informational point of view, the shipping agent is one of the main distributors of information, being in close contact with both forwarding agents and with the loading terminals, with the Port Authority, and with the ship-owner or shipping company.
Stevedoring company	This agent is in charge of the goods handling operations and is the interface between the sea and the land modes. The most usual way of working is with an administrative concession, giving it exclusive use of a space situated on the quay, operating within a certain inland terminal. Its duties cover shipment (receipt, loading and stowage), and landing (unstowage, unloading and delivery), together with all related tasks (emptying of containers, product handling, container and goods movements, etc). It acts directly on the goods.
Forwarding Agent	The forwarding agent is in charge of coordinating the transport of the goods from the company of origin (exporter) to the company of destination (importer). It interacts with all the agents that at some time have a connection with the ownership and handling of the goods, coming into contact with customs agents, shipping agents, haulers, stevedores, importer and exporter, etc. There may be just one or several forwarding agents for the movement of the cargo, depending on whether it is the same one entrusted with the transportation of the goods from their origin to their destination or different ones for the different sections. This is important, as the rest of the agents need to know who is in charge of the transportation at all times. One of the forwarding agent's coordination tasks is to be continuously

	informed about both the physical and the administrative situation of the goods, and the possible incidents that may occur on handling them, in order to advance with the transport formalities.
Clearance customs	The Clearance agent is in charge of carrying out the goods clearance formalities with Customs in representation of their owner. It is therefore responsible for presenting the necessary documents for customs clearance to Customs and for requesting inspections, when necessary, from the official organizations, and for paying the tariffs and taxes required on behalf of the owner of the goods. It is the only body that can intercede with Customs on account of third parties, and it has to be at the disposal of this organization throughout the clearance, in order to answer any query during the process and to resolve the incidents that arise

Table 3: Description of the relevant agents operating in the Seaport of Barcelona

The faster and cheaper a port can offer this transport mode changeover service, the more efficient and competitive it will be. Therefore, obviously in addition to its geographic location, the competitiveness of a sea port is determined by other factors, such as the availability of good land infrastructures (main roads and railway lines), the existence of suitable docks and means to handle the goods, the safety of the goods within the port area, the tariffs applied to the passage of goods through the port, and the time the goods remain in the port area.

The amount of information exchanged between companies creates a bottleneck. The information has to be introduced by several organizations at various points of the transport network, which leads to mistakes and delays. A further problem is the fact that the documents often travel physically together with the cargo, basically due to legal requirements. This means that these documents cannot be processed until the cargo arrives. Traditionally the administrative interactions have been highly paper-intensive, therefore, from a technical-economic perspective (Kumar et al. 1998) the standardization, rationalization and automation of these inter-firm data exchanges with ICT such as an industry IOIS, may enhance the efficiency of the whole transport network. Thus an industry IOIS is also meant to determine the competitiveness of a sea port. An industry IOIS may connect the multiple information systems operated by a variety of organizations that make up the seaport community. It intertwines the activities of the firms

operating in the port community, and therefore, embeds the business logic of the message exchanges at the community. The promise of an industry IOIS is to enhance the efficiency and effectiveness of the interactions among the community members by giving access to pertinent data on time.

Throughout the 1980s and 1990s, several of the port communities worldwide set up industry IOISs to support the EDI, cargo tracking, electronic documentation, etc, for the organizations that operated in their logistic communities (see Figure 3). These industry IOISs, which aimed at speeding up the passage of the goods through the port area, were based on the development of transactional platforms enabling the companies operating in them to exchange data electronically instead of doing so using manual mechanisms (fax, telephone, letter, etc.). These industry IOISs support the information flows between the landside and seaside transport chains (see Figure 3). Some of the examples are: Rotterdam with the INTIS, later called the EDI-LAND system and nowadays called PortInfoLink, Hamburg with the DAKOSY system, Marseilles with the GYPTIS system, Geneve with the SET system, Antwerp with the SEAGHA system, Felixstowe with the MCP system, Singapore with the TradeNet and more recently the Portnet system, Hong Kong with the TradeLink and more recently the Arena system, New York with the SeaLink system, and in Spain: Valencia with ValenciaPortPCS, Bilbao with eBilbaoPort, and Barcelona with PortIC.

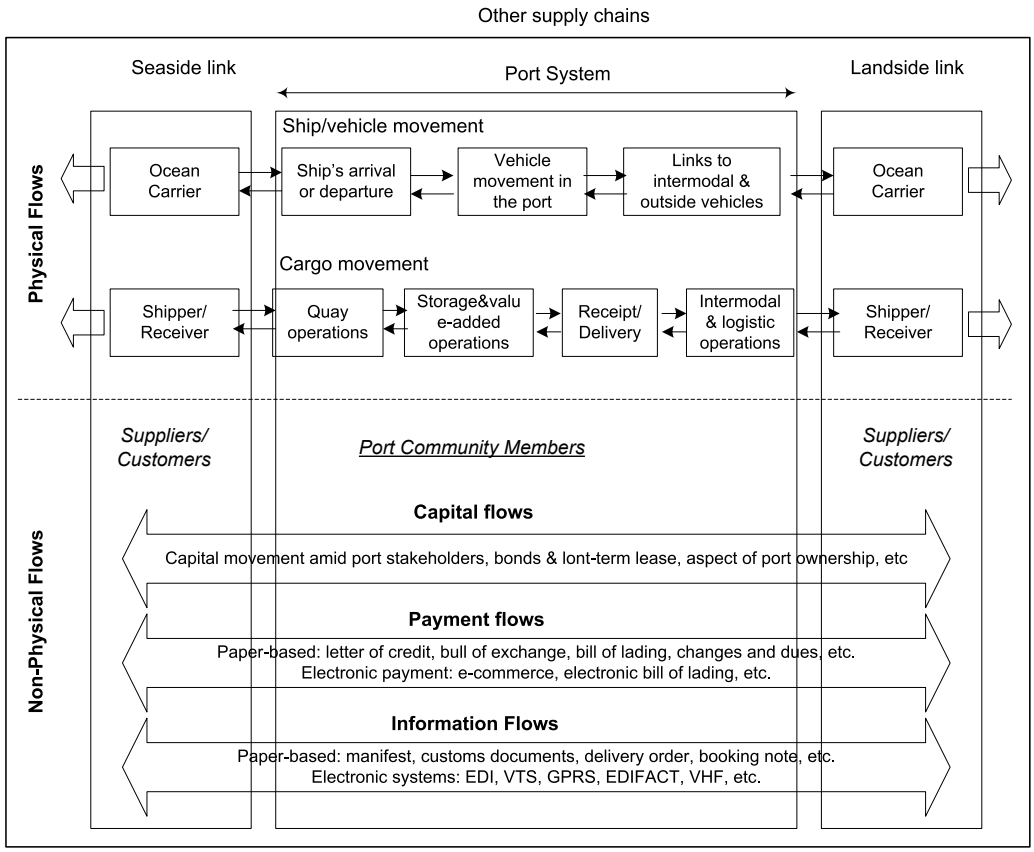


Figure 3: Flows between the landside and the seaside transport chains (UNCTAD 2004).

3.2 The Industry IOIS in the Port of Barcelona

The Port of Barcelona is Catalonia's main transport and service infrastructure. It is southern Europe's gateway for the African and Atlantic markets, and with over 20 km of docks it is connected to 423 ports worldwide with 313 scheduled lines. In 2006, with traffic of almost 46.4 million tones of cargo, and 2.3 million of containers, the Port of Barcelona was one of the leading Mediterranean and southern European ports. It is also the Mediterranean port with the most container traffic with the countries of the Far East. The Port of Barcelona's "Strategic Plan 1998-2010" considers the port needs to become the leading Euro-Mediterranean logistic hub. This involves the development of two main roles: 1) to become an intermodal centre, which requires the development of a widespread, interconnected offer of all transport modes and specialties; and 2) to

become a distribution and supply platform, which requires the development of distribution and supply, and post-industrial and pre-commercial logistic services.

At the beginning of 1994, the Port Authority of Barcelona (PAB) pioneered a Spanish project called COMPAS that aimed to speed up customs clearance and improve the handling of goods at the port by extending electronic data exchange to all the documentary formalities between the private organizations and public bodies. For that purpose the PAB created a commission, called the Information Guarantee Commission (IGC). The outcome of the commission was the standardization, for the first time, of the document exchange procedures, and the definition of the EDIFACT messages for the documents that private organizations had to submit to the PAB and Customs. The messages were supposed to be valid for several sea ports in Spain.

However, once these procedures and messages were designed, most of the companies in the port of Barcelona did not adopt them. The main argument was that most of the companies were small and did not have the required ICT capabilities to implement them. In 1997 the PAB, perceiving the need to boost the adoption of electronic mechanisms for the interaction between organizations, decided to lead and commit itself to a new project that involved the development of an industry IOIS. The goals of the project were:

- To simplify, automate and integrate the document exchange procedures related to the flow of cargo at the port
- To develop ICT services to support document exchanges and to provide information to the end users of the port
- To assist the port agents in reducing the access barriers to the new ICT.

In July 1997, the PAB presented the new project to the various associations[13] at the port for the purpose of obtaining their consensus and commitment. In October 1997, the PAB started to develop a master plan for the project of building the IOIS. The plan would contain the composition and structure of the potential users of the new system, the analysis of similar projects that had been developed in other ports, and the analysis of the most suitable management and technological model for the new system.

In 1998, the PAB governing council dissolved the IGC to form the Fòrum Telemàtic (TelFor). TelFor (Figure 4) was a discussion forum (a standard-setting consortium) for the improvement and automation of the documentary procedures that took place between the various actors intervening in the port. TelFor continued and extended the work of the IGC to those inter-organizational processes between private organizations, and to the design of the EDIFACT messages corresponding to the documents exchanged in those processes.

[13] Private Foundation of Shipping Agents of Barcelona, Association of Port Stevedores of Barcelona, Private Foundation of Shipping Agents of Barcelona, Association of Forwarding Agents, International Forwarders and Related Companies of Barcelona, Official Association of Customs Agents and Brokers of Barcelona.

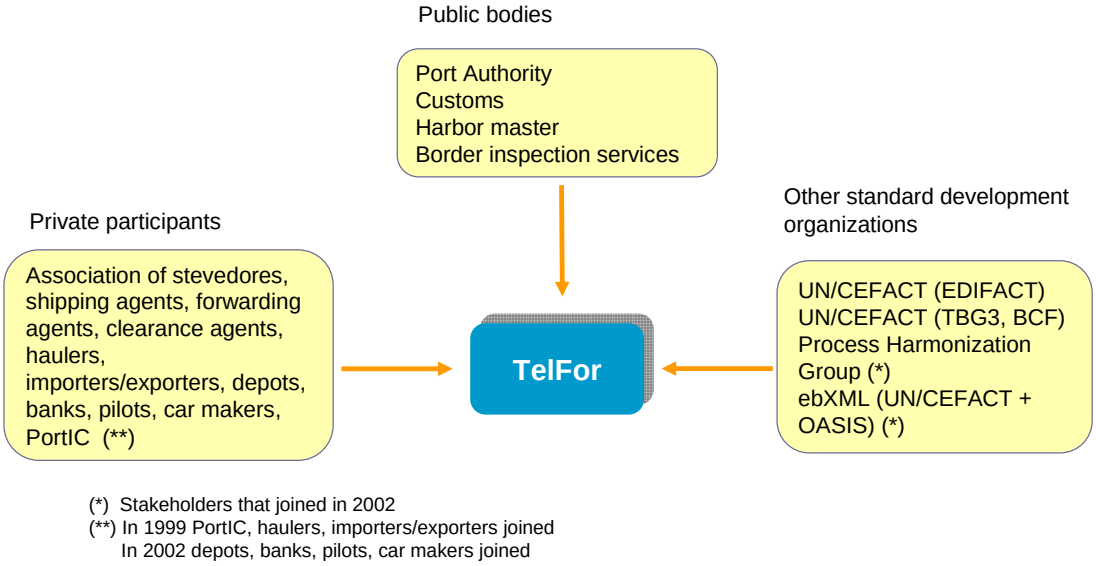


Figure 4: Stakeholders in TelFor

In February 1998, the master plan was finished and approved by the governing council of the PAB. From then on, a team from the IS Department of the PAB started defining the specifications of the new system, which would be called PortIC (Port Information and Communication System). PortIC would coordinate the activity of firms in the landside transport network of the port and integrate all the information being exchanged between the various port agents (Figure 5).

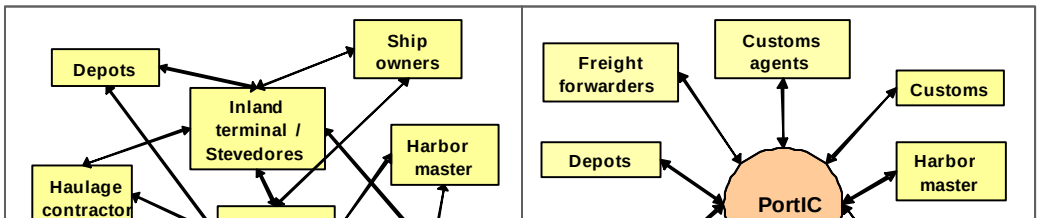


Figure 5: Envisioned scenario for PortIC

For the development of PortIC, the PAB used a formula of open public tenders. The call for proposals was split into three main blocks: (1) development of the document exchange system and the information services; (2) establishment of communications with other value added networks; and (3) administration and maintenance of the system for ten years, as well as the contracting of future developments for three years. In September 1998, after they received the analysis and the evaluation of each of the proposals, the project was awarded to the joint venture formed by Grupo CP Software and Gedas Ibérica[14].

In February 1999, the PAB, the five associations at the port and the Chamber of Commerce, which represented importers and exporters, set up a company (PortICCo) to manage the operation of PortIC when completed, in May 1999. In the envisioned scenario, PortIC should:

- Implement the standard defined by TelFor (*Fòrum Telematic*).
- Capture the information produced in any exchange within the community, thus avoiding the need to retype data, substituting paper, and reducing errors and processing costs.
- Centralize all the information of the port community.
- Provide transparency and real-time information to facilitate the tracking & tracing of goods and thus reveal inefficiencies.

To fulfill this envisioned scenario PortICCo offered three types of services: (1) Private-to-public exchanges: exchanges between a private organization and a public body (i.e. cargo manifests, dangerous cargo declarations, customs requests, customs responses, etc.); (2) Private-to-private exchanges: exchanges between private organizations (i.e. bookings, shipping instructions, acceptance orders, etc.); and (3) Real-time information services

[14] Grupo CP Software was acquired by Getronics NV in January 1998. Gedas Ibérica is part of the group Gedas AG. Gedas AG was bought by T-Systems Enterprise Systems GmbH in December 2005.

via a browser to allow the documentary tracking & tracing of containerized goods within the port.

On the other hand, most of the existing industry IOIS, which the PAB analyzed in the master plan (October 1997-February 1998), had been developed during the 1980s and beginning of the 1990s. Many were proprietary solutions or evolutions of these, based on private point-to-point connections between companies, or on value added networks, with technologies of extended but not universal use. The technological situation at the end of 1997 was completely different. Internet technologies[15] were spreading rapidly, and this represented an opportunity to use these technologies to build a solution that would give universal, low-cost access and achieve the integrated processing desired by the Port Authority. Accordingly, PortIC was conceived to give everyone in the port access regardless of the systems they had in place. Thus PortIC technology was based on the Internet. Companies could send and receive messages from PortIC in the several formats defined by TelFor (EDIFACT, XML, and flat file) by using any of the several communication services (ftp, oftp, email). For those who did not wish to integrate the incoming and outgoing messages with their in-house applications, PortIC developed a standalone Java-based application (FrontEnd) that ran on a PC and could be used for the generation and reception of messages. In order to guarantee the security of the transactions, it was decided to use cards with digital certificate and PIN (Personal Identification Number) to authenticate the access, the encryption of messages using SSL, and access and control profiles for the access control statistics (Figure 6).

[15] TCP/IP communications protocol, and access to information using browsers (www), which could operate on any PC.

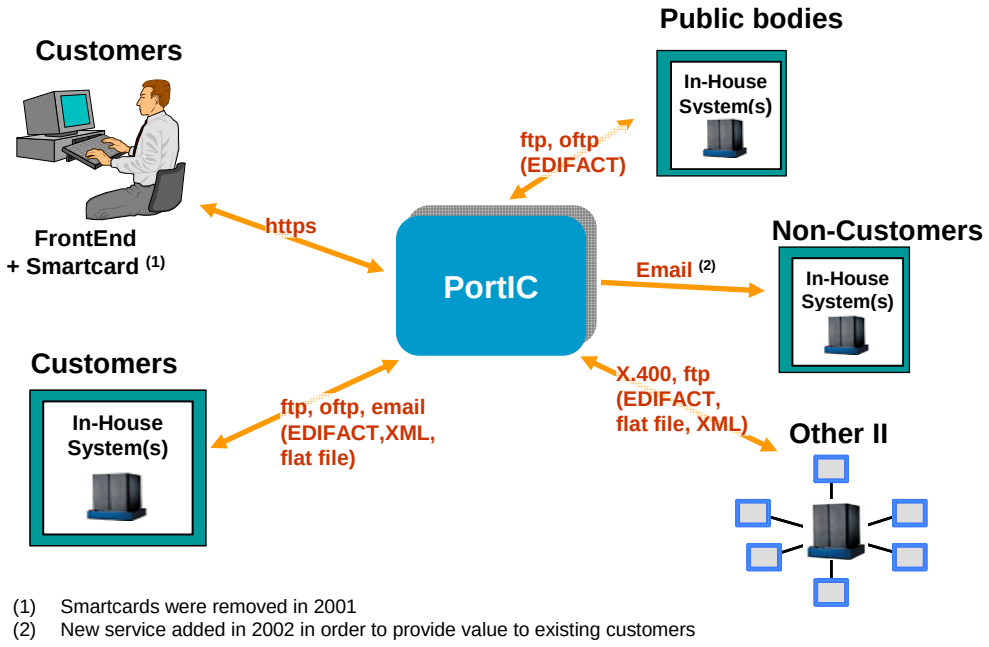


Figure 6: General ICT architecture of PortIC

Next table summarizes the relevant events that occurred from the conceptualization of the standardization process since the first version of the PortIC system was launched (end 1999). The papers in this thesis study diverse facets of the period 1994-2005. For instance, paper 2, "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective", studies the whole implementation process during the period 1994-2005. Paper 3, "A Process-Stakeholder Analysis of B2B Industry Standardisation", focuses on the study of the standardization process that took place during the period 1994-2003. And paper 5, "The Role of Emergent Strategies in Managing the Implementation of Industry IOIS", studies how ports agents integrated their systems with PortIC during the period 2001-2005.

Date	Description
Beginning 1994	The Port Authority of Barcelona (PAB) pioneered a Spanish project called COMPAS, and created the Information Guarantee Commission (IGC) in order to standardize the Customs clearance and the communications between public bodies (Customs and PAB) and private port agents.
July 1997	The PAB presents the idea for the industry IOIS to the port associations.

October 1997	The PAB starts the development of a master plan for the new project.
February 1998	The master plan is approved by the council of the PAB. A team from the PAB starts working on the definition of the new IOIS (PortIC). The PAB governing council dissolves the IGC to form the "Fòrum Telematic" (TelFor), which will extend the work of the IGC.
September 1998	The implementation of the IOIS is awarded to the joint venture formed by Grupo CP Software and Gedas Ibérica.
February 1999	PortICCo is founded by the PAB, the five associations at the port and the Chamber of Commerce. PortICCo is due to start managing PortIC in May 1999.
End 1999	A first version of the PortIC system is launched six months behind schedule. The applications offered are information services and private-to-public exchanges. Private-to-private exchanges were still under-development.

Table 4: Chronology of events in the development of PortIC (1994-1999)

4 Research Findings

4.1 The Papers

This thesis includes six papers. I will present them not in chronological order, reflecting the research journey. Rather, I will present them in order to make sense according to the research topic (see Figure 7). The papers have been written with different co-authors at different stages in the research process, with each paper focusing on different aspects of IOIS implementation in accordance to the initial research questions as stated in the introduction.

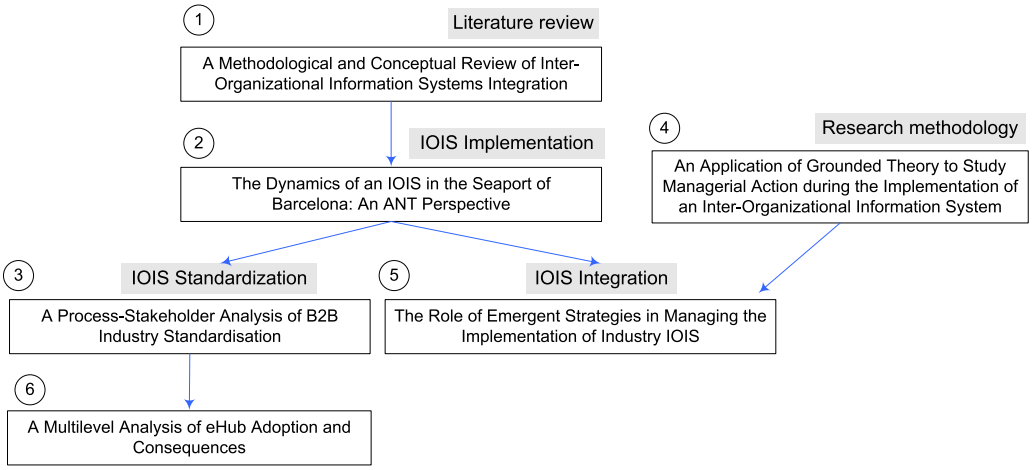


Figure 7: Structure of Papers analyzing the research problem

Out of the six papers one is a literature review (paper 1), four are empirical (papers 2, 3, 5 and 6), and one presents the application of grounded theory (paper 4). The papers vary in terms of theoretical emphasis, time of production, and the degree of maturity of the researcher (the chronological order of the papers has been 3, 6, 1, 2, 5, and 4). Each of the research papers addresses different research problems. All together provide a holistic perspective of the research problem. First, I present the abstract for each of the papers, and next I discuss the findings. The relationship between the initial research questions and the four empirical papers is illustrated in Table 5:

Research question	Papers
RQ 1: How IOIS implementation unfolds over time?	Papers: 2, 3, 5
RQ 2: How do the socio-technical actors interact throughout the implementation process?	Papers: 2
RQ 3: How can the implementation process be managed?	Papers: 3, 5

Table 5: Relationship between the research questions and the papers

Since the six papers have diverse findings at the several stages of the research project, section 4.2 aims at structuring the findings from the longitudinal case study in a more coherent that gives answer to the research questions. The reader should read the papers for a better contextualization of the findings.

4.1.1 Paper 1: "A Methodological and Conceptual Review of Inter-Organizational Information Systems Integration"

Reference:

Rodon, J. (2006) "A Methodological and Conceptual Review of Inter-Organizational Information Systems Integration", accepted in the 14th European Conference on Information Systems, June 12-14, 2006, Göteborg

Abstract:

The proliferation of applications to support cross-enterprise processes has left companies nursing a collection of systems. The integration of such systems, within and across the organizational boundaries, remains a top issue of researchers and practitioners' agendas. Although integration has long been treated as a key variable in the IS field, the construct has received little conceptual scrutiny. In this essay we argue that the concept of IOIS integration (cross-enterprise integration of information systems) is still ambiguous and lacks an understanding on its nature. Thus we explore prior literature that has attempted to conceptualize IOIS integration. We examine dimensions that concern both the methodology used (epistemology, theoretical perspective, research approach, duration of the study, conceptual model and unit of analysis), and the construct (scope, layer of integration

and conceptualization of the ICT artifact). Sixty-one articles are reviewed. We present the results and discuss different dimensions of the construct (definition, antecedents, consequences and measures). The purpose of this literature survey is to shed some light on the IOIS integration construct as well as to uncover areas for future research.

4.1.2 Paper 2: "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective"

Reference:

Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective", in IFIP International Federation for Information Processing, Volume 235, Organizational Dynamics of Technology-Based Innovation: Diversifying the Research Agenda, eds. McMaster, T., Wastell, D., Ferneley, E., and DeGross, J. (Boston: Springer), pp. 297-314.

Abstract:

On the basis of a longitudinal interpretive case study, this paper explores the dynamics in the implementation of an industry interorganizational information system (IOIS). The paper covers 11 years (1994–2005) of the implementation process. We use the lens of actor network theory (ANT) to analyze the process of emergence, development, and progressive stabilization of a socio-technical network, that of the IOIS. We focus on the negotiations and translation of interests that occur during the implementation of the IOIS. By using ANT we develop a different reading of the implementation process, which we believe provides a holistic view of the implementation, and can be adapted and applied to similar implementation projects. ANT is suitable as it helps us trace the course of the implementation, and because of the nature of the IOIS and of the implementation process, which involves political negotiations.

4.1.3 Paper 3: "A Process-Stakeholder Analysis of B2B Industry Standardisation"

Reference:

Rodon, J., Ramis-Pujol, J. and Christiaanse, E (2007). "A Process-Stakeholder Analysis of B2B Industry Standardisation", *Journal of Enterprise Information Management*, 20 (1): 83-95

Abstract:

Companies require standards for their information exchange processes that extend beyond their boundaries. We argue that the interorganisational IS standard development processes deserve closer attention as they are a crucial aspect in the development of B2B e-business. The aim of the paper is to understand how the standardisation evolves by analyzing the interplay between activities and stakeholders along the process. This paper contributes to the literature on vertical B2B standardisation by combining process theories and stakeholder analysis approaches. A case study of a consortium-based industry standard creation process is discussed and analysed. We found that the interplay between stakeholder tasks and roles in relation to their stakes, have a significant impact on the outcome of the standardization process.

4.1.4 Paper 4: "An Application of Grounded Theory to Study Managerial Action during the Implementation of an Inter-Organizational Information System"

Reference:

Rodon, J., and Pastor, J. A. (2007), "An Application of Grounded Theory to Study Managerial Action during the Implementation of an Inter-Organizational Information System", 6th European Conference on Research Methodology for Business and Management Studies, Lisbon.

Abstract:

This paper shows the application of Grounded Theory (GT) method in a research project that studied the role of managers of an inter-organizational

information system (IOIS), during and after the implementation of the IOIS. We present the steps being followed –sampling, data collection, analysis, and literature comparison–, paying special attention to the intricacies that arose during the research process, and we reflect on the lessons learned from using GT in an interpretive case study. We favoured the "Straussian" version of GT over the "Glaserian": first, because the former view treatment of the existing literature, and second, because the Straussian version provides us with the coding paradigm analytical technique, which allows us to focus on process data. The paper shows: firstly, how grounded theory analytical techniques are useful to analyze process data; secondly, how action diagrams can help structure and report on process data; and, thirdly, the importance of flexibility, creativity, and being open mind in using the analytical tools of GT because it may take different directions before a plausible theory starts to emerge. The objective of the paper is to give a personal perspective that may help novice researchers in the use of GT

4.1.5 Paper 5: "The Role of Emergent Strategies in Managing the Implementation of Industry IOIS"

Reference:

Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Role of Emergent Strategies in Managing the Implementation of Industry IOIS", 67th Academy of Management Annual Meeting, Philadelphia.

Abstract:

A dominant implicit assumption in the literature on inter-organizational information systems (IOIS) is that the implementation of the IOIS is rationally planned, it goes according to a plan, and use follows as expected. Contrary to this assumption, this empirical paper shows that the management of IOIS cannot only be conceived as pre-defined planned intervention, but also as a form of reaction and response to situational demands and users' behavior. IOIS emerge from users' enactment and

reinforcement of the system, which managers have difficulties in foreseeing and cannot avoid. We present a case study about the implementation of an industry IOIS in the Seaport of Barcelona. Using Grounded Theory method, we have found five maneuvers that the IOIS management undertakes during and following the implementation in order to encourage and support the use of the IOIS. Next, drawing on the literature of mutual adaptation, organizational change, and emergent strategies, we interpret these managerial maneuvers. Finally, we show that the five managerial maneuvers converge into two emergent strategies: attract users to bootstrap the IOIS, and keep the IOIS adaptable.

4.1.6 Paper 6: "A Multilevel Analysis of eHub Adoption and Consequences"

Reference:

Christiaanse, E., and Rodon, J. (2005) "A Multilevel Analysis of eHub Adoption and Consequences", *Electronic Markets*, 15 (4):355-364.

Abstract:

Although there has been a significant amount of research on the adoption of IS standards and consequences, most has tended to focus on traditional EDI standards, paying special attention to factors of individual adopters. However, the current proliferation of new IS standards, based on open technologies, increases the potential for interorganizational collaboration. Research, therefore, needs to raise the level of analysis to that of the constellations of organizations that are part of the industry network. This contribution examines how the structural properties of the network impact on the adoption decision and how the adoption in turn produces changes in the structure of the network. Furthermore, we advocate a multilevel analysis of the consequences of using IS standards and eHubs. We explore and illustrate our theoretical arguments with a case study on the adoption and use of an IS standard and eHub in the chemical industry.

4.2 Findings

Although the findings can be found in the individual papers, next I try to summarize and group them. Likewise, with these findings I give answer to the three research questions of the thesis.

4.2.1 The need for an ensemble view and processual approach on IOIS implementation research (paper 1)

In paper 1, "A Methodological and Conceptual Review of Inter-Organizational Information Systems Integration", I conducted a literature review of 61 papers in the IOIS area. After analyzing the concept of IOIS implementation, standardization and integration, I concluded that: a large number of papers view IOIS implementation as being materially determined, and they consider that developments in information and communications technologies promise the ability to more easily implement IOISs, as these technologies are expected to reduce the relationship-specific investments required and facilitate the syntactical interoperability between the different systems that constitute the IOIS.

However, as sundries authors recognize, the real challenge of implementation does not only lay within the technical realm, but in the socio-technical realm (Waring et al. 2000). This entails adopting an ensemble view of IOISs (Orlikowski et al. 2001), which stresses the utilization of the IOIS as embedded in a social context and thus the need to pay attention to context (Avgerou 2001; Orlikowski et al. 2001). In line with this perspective, theoretical lenses such as actor-network theory, which examine the interplay between the social and the technical by making no analytical distinction between them, seem adequate.

The literature review also found that a great deal of prior literature was based on the assumption that IOIS implementation deterministically implies organizational and inter-organizational results (Barua et al. 2004; Bergeron et al. 1997; Mukopadhyay et al. 2002). Based on this assumption, some researchers conceptualize implementation as a set of stages, each one

indicating more maturity, more control, and more efficiency (Angeles et al. 2000; Clark 2001; Swatman et al. 1994). However, organizational efforts such as IOIS implementation are shaped by human actions and choices, and at the same time are prone to bring surprises to organizations as the implementation may indeed produce rather than curb disorder. For instance, if the features of the IOIS fail to meet the users' needs, they may create workarounds as a result.

Finally, previous research has mainly conceptualized IOIS implementation as an event, not an ongoing process, and therefore it has applied one-shot cross-sectional data collection and analysis. However, IOIS implementation is expected to be a cumulative process and to become path dependent in the sense that existing systems will influence the structure of the IOIS as well as the choices and paths for integrating the pre-existing systems with the IOIS. Separate information systems become integrated over time into complex ensembles of heterogeneous technical artifacts, which are increasingly connected with and dependent upon one another. Based on this process view of IOIS implementation, I suggested that theoretical frameworks that examine the actions taken by different actors to appropriate the features of the IOIS, modify their working procedures, their organizational structures or their communication patterns as a result of implementing the IOIS seem adequate.

4.2.2 Findings related to the evolution of the implementation process (papers 2, 3, and 5)

First, papers 2, 3 and 5 show that the evolution of the implementation process can not be predetermined. Rather, the implementation process is full of surprises –i.e. unexpected uses, contradictory interests, and so on–, thus the path it takes is constantly negotiated between the different stakeholders. To study these negotiations I adopted a processual approach that looked for sequences of events, adaptations, adjustments, appropriations and reinventions of the technology that occurred during and after the implementation process, and that described how things change and

unfold during the implementation of the IOIS. For that purpose I used grounded theory and actor-network theory.

Secondly, the promoters of the industry IOIS and the standard adopted a technology-deterministic or techno-economic rationale (Kumar et al. 1998) that focused on the efficiencies that members of the port community could get as a result of an standardization effort and the later construction of an industry IOIS. Because promoters perceived that the IOIS represented an improvement for the community, they built the technical system and expected potential users would adopt it. They succeeded in the case of information services and private-to-public exchanges, but failed in the case of private-to-private exchanges as a hardly noticeable percentage of firms used the IOIS. The promoters were incapable of integrating the multiple and divergent interests. After several failures in the implementation, promoters adopted a different approach, which consisted of adapting to the demands of adopters and accommodating heterogeneity. Managers performed a set of actions that aimed to align the interests of groups of potential adopters. That way, managers were able to keep the well functioning of these groups of firms and allowed the industry IOIS to bootstrap. As firms are part of several groups, subsequent integration efforts were easier and took less time. This alignment of interests shows that there is some feedback, which actors take advantage of in subsequent integration efforts. This complements diffusionist IS-based studies that view implementation as going through distinct stages exhibiting little or no feedback. Moreover, this alignment was also characterized by an active involvement of all adopters who constantly shaped the development of the IOIS. At first, their role was more passive; they accommodated to IOIS requirements but hardly had any voice in the design and development of the IOIS. Later they had a more active role. This latter approach to IOIS implementation is closer to cultivation (Aanestad et al. 2000) than to construction (technological determinism). In construction control is under those who design and engineer to shape the system. On the other hand, in cultivation not only designers do have influence in the implementation process, but also others, the pre-existing systems, the

procedures, the standards, etc, shape the process. Accordingly, IOIS implementation is both construction and cultivation: actors not only rationally plan and control the implementation but also nurture it.

Finally, paper 2, "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective", uses actor-network theory to examine the dynamics of the implementation of the IOIS and shows that the implementation process may be regarded as the emergence, development and stabilization of the actor network that constitutes the IOIS. Using the four moments of the translation process –problematization, interessement, mobilization, and enrollment– (Callon 1986), the paper shows that IOIS implementation can be viewed as chains of translations that run sequentially or in parallel. Each translation process emerges as it is triggered by a problem or an opportunity. On the other hand, a translation process may succeed or halt at any stage. When a translation process succeeds the actor-network stabilizes and it can be treated as a black-box –either an artifact, or a rule, a standard, etc.–, that is, it is very difficult to go back to a point where the translation was only one among many. Likewise, when the translation stabilizes it may shape other translations. If the translation halts –because of technical or social-political tensions–, then it may be necessary to backtrack. Prior alliances may weaken. The higher the degree of convergence within a network –the better, easier and more reliable the translation process works– the more powerful it becomes.

4.2.3 Findings related to the interaction of socio-technical actors throughout the implementation process (paper 2)

Paper 2 draws upon actor-network theory to inquire into the interplay among diverse actors (public bodies, private organizations, artifacts, procedures, standards, etc.) during the implementation of the IOIS. The paper shows that the IOIS may be regarded as a stabilized set of relations between human and non-humans artifacts and rules forming an actor-network.

The industry IOIS was fixed as the obligatory passage point (Callon 1986). That is, the IOIS had to be successfully implemented for all the actors to satisfy their interests. This obligatory passage point was in the direct path of some of the actors: the Port Authority of Barcelona and the company managing the IOIS. On the other hand, some actors had difficulties in passing through this obligatory passage point, but these actors had to pass through it if they wanted to avoid some threats and attain their objectives. The main difficulties actors had to face relied on the diversity of interests and objectives. Moreover, as the actor-network grew, the conflict increased because of this divergence of interests. The paper shows that some of these interests, especially those of the installed base of systems and processes, are not easily foreseen. Thus during the implementation process it is important to unpack the black-boxes that constitute the installed bases, as they are unstable allies because they feel threatened by the new system.

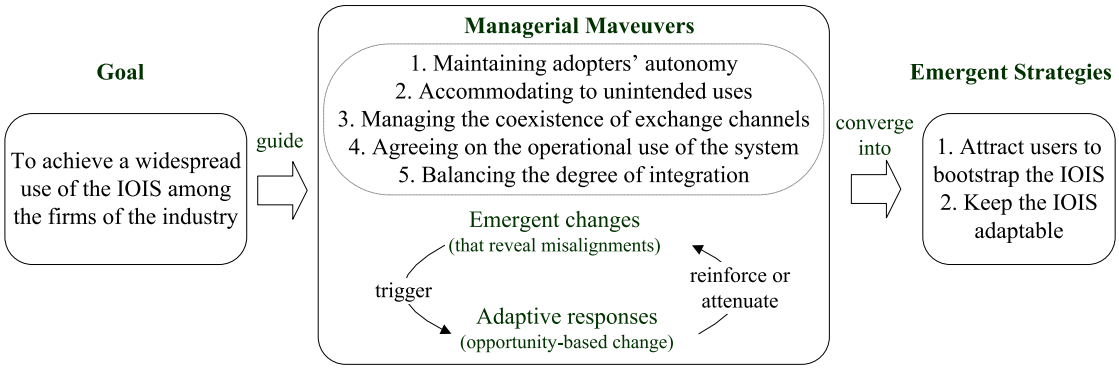
Finally, paper 2 also shows that information technologies can play a major role in the image-making strategy, as they mediated the discourse of the promoters. The focal actors, the Trade Associations, press articles, and consulting firms portrayed the industry IOIS as the inevitable direction to enhance the competitiveness of the port and create a paperless port, which meant more efficiency in terms of time, cost, and infrastructure optimization. This techno-economic view was attractive not only because of the consequences they carried, but also because of the easily explanations for a successful story. The IOIS was presented as being technically advanced. In addition, well established IS consultancies would be in charge of the implementation. Thus information technologies were a rhetorical instrument in the persuasion campaign carried by focal actors. However, this strategy finally failed when the project was close to collapse. Focal actors had not fully taken into account the role of other actors –the port agents' systems, interests, internal processes, skills, working habits, etc– in shaping the implementation process. Focal actors' assumption had been that the implementation process would be mainly shaped and controlled by focal

actors' designers, and that the port agents would adopt it and the installed base would adapt.

4.2.4 *Findings related to the management of the implementation process (papers 3 and 5)*

Paper 5, "The Role of Emergent Strategies in Managing the Implementation of Industry IOIS", shows that in the management of IOIS coexist two modes of operation. One characterized by intended formal planning, in which the implementation goes according to plan and use follows as expected, and another characterized by maneuvers triggered by local reinventions, adaptations and drift. In the second approach, the IOIS emerges from users' enactment and reinforcement of the system, which managers cannot avoid because they have difficulties in foreseeing, and the managerial responses to accommodate unforeseen events. The users' interventions as well as the adaptive responses that managers perform may be interpreted as maneuvers. That is, they are short-tem, rapidly moving, dictated by and forcing the seizing of the moment. In contrast to formal, straight, stable and rigid interventions embedded in methods and plans, maneuvers are contingent actions that are meaningless outside the specific situation (Mintzberg 1994). They are needed to fill the gaps of formal planning and to cope with unintended consequences.

Paper 5 proposes the "Model for Managing the Post-Implementation of IOIS" (p. 30) that summarizes in a pragmatic way the strategies adopted by management to facilitate the integration of pre-existing systems with the IOIS and boost the usage of the IOIS.



First, a relevant goal for the IOIS management, in the post-implementation stages, is to achieve a widespread use of the IOIS among the firms of the industry. This goal affects and guides managers' decisions and actions. Second, in the daily operation of the IOIS, managers have to deal with emergent changes (Orlikowski et al. 1997) –i.e. unexpected user appropriations of the system. Such emergent changes create unforeseen conditions and reveal misalignments (Leonard-Barton 1988), which trigger managers to perform adaptive responses (opportunity-based changes) in order to reinforce or attenuate them; in turn, as managers respond, new unintended outcomes and changes may emerge. The role of IOIS management is that of a sense maker who redirects change: management recognizes emergent changes, makes them more salient, and reframes them (Weick et al. 1999). The adaptive responses that arose from the case were grouped into five managerial maneuvers: maintaining adopters' autonomy, accommodating to unintended uses, managing the coexistence of exchange channels, agreeing on the operational use of the system, and balancing the degree of integration. Finally, it can be observed that these maneuvers converge into two strategies in action, also referred as emergent strategies (Mintzberg 1994): attract users to bootstrap the IOIS, and keep the IOIS adaptable. These two emergent strategies seek to grow the installed base of uses and the use of the IOIS.

On the other hand, paper 3, "A Process-Stakeholder Analysis of B2B Industry Standardisation", presents an example of standardization coordination through a consortium. This consortium is open to all the

organizations, private companies and public bodies, which are part of the Port Community of Barcelona. The outcome of this process is a formal standard which is the result of a consensus among all the port agents. The paper shows that adequate stakeholder participation is essential to the standardization process. First, the fit between stakeholders and their roles during the standardization process increases the options that the standardization will come to an end and that the standard will be accepted and adopted once it is completed. Second, as the stakes may change during the standardization process, a continuous identification of participants' stakes appears to be very important. Finally, the fact that a manager of the standardization process focuses on sense-making activities during the initial steps of the process avoids that the work of participants gets stuck with reiterations and potentially does not get to the further steps of the standardization process.

4.2.5 A network approach to the study of IOIS implementation (paper 6)

The use of industry IOIS takes place in networks of organizations, who combine their capabilities in order to compete effectively and respond to more agile changing environments (van Heck et al. 2007). Therefore, the study of IOIS may pay attention to the structural properties of the network.

Paper 6 examines how the structural properties of the network affect the adoption decision and how the adoption in turn produces changes in the structure of the business network. The paper addresses: (1) the structure of an industry network –centrality, structural equivalence and density– as affecting the adoption decision; (2) the adoption of an IOIS within an industry network may have a direct effect on the flow of network resources –information, assets and status–, and these effects, in turn, will produce changes in the structural properties of the network; and (3) the final argument is that the adoption and subsequent use of IOIS may create collective benefits for the industry that go beyond the organizational and dyadic levels. The paper advocates research that raises the level of analysis to the constellations of organizations that are part of the industry network. The

paper argues for a multi-level analysis of the consequences of using IOIS standards and IOIS. Theoretical arguments are illustrated via a case study of an IOIS in the chemical industry called Elemica.

The paper contributes to the literature on IOIS by raising the level of analysis to that of the network level while exploring the embeddedness perspective in the IOIS research.

5 Contributions and Implications

This chapter aims to outline the theoretical and practical contributions that arise from the papers that constitute this thesis.

5.1 Theoretical Contributions

This section discusses the key theoretical contributions that arise from this thesis.

First, the existing literature has been reviewed critically emphasizing the need for 'understanding' and for an interpretive approach of the implementation process. Based on this gap, thesis complements prior research on IOISs, which has mainly adopted tool and proxy views (Orlikowski et al. 2001) of the IOIS. The group of studies that conceptualize the IOIS as a strategic tool focus on several successes –the case of American Airlines with SABRE, Baxter with ASAP, etc.–, and expect that their findings may provide guidance to practitioners. On the other hand, studies that conceptualize the IOIS as a proxy mainly proposed factor-based models (Chwelos et al. 2001; Premkumar et al. 1994; Ramamurthy et al. 1999), which were based on the dominant paradigm in innovation research: the diffusion of innovations theory (Rogers 1995). These factor-based models examined the antecedents and consequences to IOIS implementation. Moreover, IOIS studies that have adopted a tool or proxy views of the IOIS confined research on implementation to the boundaries of an organization.

In this thesis I have assumed that IOISs are complex, learning intensive and socially constructed systems. Thus I have adopted an ensemble view that includes artifacts, people, interests, standards, etc., which constitute the industry IOIS. I have not only focused on the technical system, the individuals, and the firms involved in the implementation, but also I have broadened the unit of analysis to the group of firms integrating with the IOIS, and to the remote environment –i.e. relations of those firms with other industries. Accordingly, this thesis combines a multi-level analysis with

a processual approach, and recognizes the emergent causal agency (Markus et al. 1988). The findings of this thesis add to the limited group of researchers (Damsgaard et al. 2001b; Hanseth et al. 2006a; Kumar et al. 1998; Kurnia et al. 2000) who have focused on the processual and socio-technical nature of IOIS.

Adopting a processual approach that studies the changes during the implementation of IOISs requires the collection and analysis of processual data across multiple timeframes. Due to the dynamic nature of IOIS implementation the longitudinal research approach was meant to be very suitable to study the implementation process. Accordingly, this work also adds to the limited number of longitudinal studies in the IS field (Walsham 1993) by providing a deeper contextual understanding of the processes of adaptation and change that underlie IOIS implementation.

Second, in comparing the diffusion and translation models –the latter being informed by actor-network theory–, Latour (1987) contends that in diffusion models what needs to be explained of an innovation –i.e. the IOIS– is its acceleration or slowing down which must then be due to human-actors. Latour notes that diffusion models define three important elements in the movement of an idea or innovation: the initial force with which it is launched, the innovation's inertia, and the medium through which it moves. The advantage of diffusion models is that anything can be explained by reference to the initial force or the resisting medium (Latour 1987; McMaster et al. 1997). However, as Latour notes there are occasions when the diffusion does not occur despite the excellence of the innovation, and then the diffusion models find these difficult to explain. On the other hand, as this thesis shows, in the translation model the initial idea –the IOIS– has neither power nor inertia, and only moves if it interests a group of actors. When the IOIS interests new groups of actors they transform it giving it more power. That is, actor-network theory helps stress that actors' power and actions are not antecedents but result from the negotiations between multiple actors. Moreover, this thesis transfers some concepts of

actor-network theory from the study of science and physical technology (Latour 1999) to the study of the implementation of IOISs. The thesis shows that the use of actor-network theory as a theoretical lens and vocabulary is a valuable alternative theoretical framework to the study of socio-technical developments such as IOIS implementation. It is particularly valuable to emphasize a processual aspect of the implementation, as well as the political-negotiating side of the process taking into account all the socio-technical actors that play a role. The use of actor-network theory has complemented and added to the factor-based literature on IOIS by concentrating on the issues of network formation, thus detailing how and why some factors –i.e. managerial support, IT readiness– become important.

Finally, even though prior literature on standardization recognizes that IOIS standards result from a process of social interactions between stakeholders, it has not studied the standardization processes in industry consortia, or the link between the process and stakeholder models or the impact of the structural properties of the business network on the process.

5.2 Practical Contributions

This section discusses the key contributions for practice that arise from the thesis.

The fact that the management of IOIS implementation may be viewed as an emergent process (Rodon et al. 2007c), which means that design, development, integration, and use are inseparable, has some implications for the area of IOIS management. The role that unintended uses and change play throughout the implementation process places two challenges for managers. Firstly, IOIS management has to place emphasis and devote resources not only to design, predict future conditions, and develop strategies and actions to meet those predictions, but also to pay attention and understand the unexpected events and emergent changes that arise during use of the IOIS. Secondly, IOIS implementation requires

management to respond in order to reinforce or attenuate the emergent changes.

In relation with the previous paragraph, we show that although managers may formally articulate strategies on a periodic basis (formally planned strategy), enhancing the use of the IOIS lies in their ability to anticipate surprises, watch for them, and encourage small emergent and opportunity-based changes. As Emirbayer and Mische (1998) state "if we cannot control de consequences of interventions, we can at least commit ourselves to a response, experimental, and deliberate attitude as we confront emergent problems and possibilities across the variety of context within which we act." (p.1013). That is, the IOIS management cannot only be conceived as predefined planned intervention, but also as a form of reaction and response to situational demands and others' –i.e. users– behavior. In the first phases of the implementation of industry IOISs, as the objective is maximizing adoption and use, approaches to strategizing might reasonably be closer to emergence than to the rational, deliberate paradigm (Mintzberg 1994).

The five managerial maneuvers presented (Rodon et al. 2007c) may guide managers and practitioners involved in the implementation of IOISs. Thus this thesis has pragmatic legitimacy it may serve as a helpful guide from which to improve practice. Just as these five maneuvers guide managers in the implementation process, formal design and deliberate planning may serve to fix the common foundations for the IOIS.

The use of actor-network theory has also demonstrated practical implications as it highlights the need to fix an obligatory passage point where the interests of the different actors involved should converge. On the other hand, actor-network theory also allows me to stress the importance of complying with the installed base of humans and non-humans in the implementation of IOISs. An IOIS is the result of integrating the different installed bases, thus the installed bases shape the implementation process. Therefore, any vision for an IOIS that does not align the interests of the diverse installed bases is doomed to fail.

Finally, this work also confirms the dynamism of the stakes during the standardization process and highlights that the stakeholders that participate in the standardization have a range of stakes that vary among their nature and drive their attitude towards the process. Thus a continuous identification of participants' stakes appears to be very important. Likewise, the classification of the roles (Rodon et al. 2007d) that stakeholders can play during the standardization of the IOIS may provide insights to practitioners who are involved in similar processes.

5.3 Limitations

The limitations of an interpretive study like this thesis include: the validity and generalizability of the study, the problems that researchers face when doing longitudinal studies, and the type of system being studied.

First, the validity of an interpretive case study is determined by the reader based on the evidence supplied by the study. The reader may wonder if the story rings true (Klein et al. 1999). Regarding the generalizability of a case study, Lee and Baskerville's (2003) note: "generalizability is a major concern to those who do, and use, research. Among other things, it refers to the validity of a theory in a setting different from the one where it was empirically tested and confirmed….The generalizability of an IS theory to different settings is important not only for purposes of basic research, but also for purposes of managing and solving problems that corporations and other organizations experience in society." (p. 221). From an interpretive epistemological sense the validity of the results does not depend on a positivistic sense, but on the plausibility of the inductive reasoning used in analyzing the case study findings and drawing conclusions from them (Lee 1989; Orlikowski et al. 1991). The goal of a case study is particularization, rather than generalization and the primary aim of performing a case study is not to see how the case under investigation differs from others, but simply what it is and what it does, with the emphasis being on interpretation. Therefore, given the nature of this research I cannot assure the statistical

generalizability and external validity of the findings or draw general predictive statements; rather, the contribution of this thesis is limited to generalize from empirical descriptions to theory type (Lee et al. 2003). In other words, this thesis provides rich insights, from which I have drawn of specific implications for researchers and practitioners (Walsham 1995b). Second, this long term research work has also faced the traditional problems of longitudinal research (Pettigrew 1985), which are that roles and people changed thus having practical consequences in tracing people and achieving compatible views. However, both these weaknesses –lack of generalizability and changing of roles and people– do not undermine the credibility of the research due to my prolonged engagement, my search for detail richness, my use of multiple data sources, and my involvement with key informants and contact persons, who assisted me in regularly reviewing the emerging case material. Finally, the analysis has focused on an industry IOIS that supports transactional interactions between organizations. The analysis of other types of IOISs –i.e. electronic communities of practice–, which are non-transactional systems, goes beyond the scope of this thesis.

6 Concluding Remarks and Future Research

This thesis has presented a longitudinal interpretive study that shows the evolution of the implementation process of an industry IOIS, and tried to deepen our understanding of the dynamics of IOIS implementation. In particular it has addressed two types of tasks that are part of the implementation process: standardization and integration. In addition, this thesis has emphasized the ensemble or emergent view of the IOIS –in particular the variant called technology as development project (Markus et al. 1988; Orlikowski et al. 2001). First, the IOIS is not only the technical artifact, but also the social and organizational structures that interplay with this artifact. Second, this thesis has explicitly acknowledged the significance of the context where the implementation and use takes place. This work has analyzed the specific circumstances of IOIS implementation, seeking to identify the meanings and interests involved in IOIS implementation, as well as the processes through which the implementation took place or was held back. Third, the IOIS is emergent because the actors involved in the implementation process do not mainly exhibit general rational patterns of behavior; rather, they work in the development of the IOIS while using it or while responding to the challenges they are faced with.

The first main theme of this work has been to analyze the socio-technical interplay and describe the temporal unfolding of the ongoing process of adaptations and socio-technical negotiations that occur throughout the implementation of an industry IOIS. Through a longitudinal description, a number of complex and socio-technical relationships that exist for IOIS implementation have been described. A conclusion that surfaces from this socio-technical interplay is that there is no reason why the technical and social must be analyzed separately, and that a successful implementation of an IOIS will be far more complex and long-term process than merely developing the IOIS and using it.

A second main theme of this work has been related to the role of management in the implementation of the IOIS. Previous empirical IOIS research has scarcely gone beyond a set of factors to manage during the adoption, development and use of the IOIS. The present work has shown the emergent nature of IOIS management and suggested how managers can influence the implementation process. In addition, it has shown how the implementation process combines planned and unplanned change. Several maneuvers were found to be relevant in the successful bootstrap of the IOS. We regard this contribution may be relevant not only to the IOIS area, but also to the IS area in general. This dissertation has also focused on the social negotiations of stakeholders along the standardization process, and has shown how some of the roles and tasks performed by these stakeholders may help the standardization process to move forward and increase the acceptance of the standardization outcome –the standard.

Several promising venues for future research are suggested by this study. First, further research may replicate this longitudinal study in other industries and thus add external validity to the findings of this thesis. These studies may focus on: 1) the role that stakeholders, either public or private, play in the implementation process; 2) how the IOIS cope with issues of installed base (technical and non-technical components: hardware, software applications, communications, database structures, processes, organizational structures, users, practices, skills, values, interests, preferences, etc.), flexibility and openness, 3) the problems firms have to overcome during the integration and use of the IOIS, and 4) the strategies that IOIS management follows during the implementation and post-implementation of the IOIS. Likewise, although actor-network theory (Rodon et al. 2007c), stakeholder theory (Rodon et al. 2007d) or social network theory (Christiaanse et al. 2005) have proved satisfactory in this thesis, further research may use other theoretical perspectives. For instance, to study the role of stakeholders it may seem suitable to combine stakeholder theory and institutional theory (Chiasson et al. 2005); on the other hand, as the resulting standard and the IOIS are collective goods, collective action theory seems adequate to the

study of the conditions under which organizations collaborate (Markus et al. 2006).

Nowadays, information and communications technologies have become pervasive in the many relations that organizations have with the environment in which they operate. Thus organizations become more dependent on the availability of inter-organizational information. As this thesis has presented, organizations increasingly opt for collaborating with partners in their business sector to set up an industry IOIS, which allows them to make the best use of this inter-organizational information. Accordingly, the study of the process of implementation of IOISs will remain a relevant topic for researchers and practitioners in the years to come. I think the emergent perspective presented in this thesis is an alternative and promising approach for the study of implementation and use of IOISs in their rich socio-technical context. This approach complements and adds to the current mainstream IOIS literature, which has mainly adopted technological and organizational imperatives of the IOIS and proposed variance theories. I believe this thesis, which follows the work of researchers like Lynne Markus, Wanda J. Orlikowski, Claudio Ciborra, and more recently Ole Hanseth and Eric Monteiro, may enrich current and future IS research by offering new understandings of a complex phenomenon such as IOIS implementation.

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Appendixes

1. Rodon, J. (2006) "A Methodological and Conceptual Review of Inter-Organizational Information Systems Integration", accepted in the 14th European Conference on Information Systems, June 12-14, 2006, Göteborg

2. Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective", in IFIP International Federation for Information Processing, Volume 235, Organizational Dynamics of Technology-Based Innovation: Diversifying the Research Agenda, eds. McMaster, T., Wastell, D., Ferneley, E., and DeGross, J. (Boston: Springer), pp. 297-314.

3. Rodon, J., Ramis-Pujol, J. and Christiaanse, E (2007). "A Process-Stakeholder Analysis of B2B Industry Standardisation", *Journal of Enterprise Information Management*, 20 (1): 83-95

4. Rodon, J., and Pastor, J. A. (2007), "An Application of Grounded Theory to Study Managerial Action during the Implementation of an Inter-Organizational Information System", 6th European Conference on Research Methodology for Business and Management Studies, Lisbon.

5. Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Role of Emergent Strategies in Managing the Implementation of Industry IOIS", 67th Academy of Management Annual Meeting, Philadelphia.

6. Christiaanse, E., and Rodon, J. (2005) "A Multilevel Analysis of eHub Adoption and Consequences", *Electronic Markets*, 15 (4):355-364.

Appendix 1

Rodon, J. (2006) "A Methodological and Conceptual Review of Inter-Organizational Information Systems Integration", accepted in the 14th European Conference on Information Systems, June 12-14, 2006, Göteborg

A METHODOLOGICAL AND CONCEPTUAL REVIEW OF INTER-ORGANIZATIONAL INFORMATION SYSTEMS INTEGRATION

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Abstract

The proliferation of applications to support cross-enterprise processes has left companies nursing a collection of systems. The integration of such systems, within and across the organizational boundaries, remains a top issue of researchers and practitioners' agendas. Although integration has long been treated as a key variable in the IS field, the construct has received little conceptual scrutiny. In this essay we argue that the concept of IOIS integration (cross-enterprise integration of information systems) is still ambiguous and lacks an understanding on its nature. Thus we explore prior literature that has attempted to conceptualize IOIS integration. We examine dimensions that concern both the methodology used (epistemology, theoretical perspective, research approach, duration of the study, conceptual model and unit of analysis), and the construct (scope, layer of integration and conceptualization of the ICT artefact). Sixty-one articles are reviewed. We present the results and discuss different dimensions of the construct (definition, antecedents, consequences and measures). The purpose of this literature survey is to shed some light on the IOIS integration construct as well as to uncover areas for future research.

Keywords: Integration, Inter-organizational Information Systems, Review.

1 INTRODUCTION

Integration is "the act or process of making whole or entire" (Webster's Revised Unabridged Dictionary 1913). In the IS field integration has been attributed a diversity of meanings: integration as the interoperability of systems, as developing a whole new system, as combining existing systems into one logical system, as establishing communication between systems, as inter-organizational process reengineering, as standardizing existing systems (imposing uniformity), as becoming a natural extension of the users or a routine (assimilation), or as the adoption or diffusion of a system.

From an enterprise perspective the statement "if a company's systems are fragmented, its business is fragmented" (Davenport 1998) shows that businesses at their core rely on integration of internal systems not only to maintain consistent information, but also to avoid fragmentation of their organizational structures (i.e. having autonomous management of business units or multiple views of their customers). This fragmentation problem discourse has been a catalytic driver of the enterprise systems vision.

From an inter-organizational perspective the fragmentation argument is also adequate. In the recent years the proliferation of applications to support cross-enterprise processes has left companies nursing a collection of systems (i.e. e-procurement, CRM), meanwhile practitioners have started to pay increased attention to the systems integration that bridges a firm's boundaries (Waters 2005). They consider integration as a businesses imperative which can generate value in terms of cost and time savings for businesses (Low 2002) or give them a distinct advantage (Iansiti and Levien 2004) though when lacking can put the business at risk (Girard 2004). Accordingly integration remains a top issue of researchers and practitioners' agendas.

In this essay we examine the concept of Inter-organizational Information Systems (IOIS) integration, which we define as the integration of systems that belong to different organizations. IS researchers have long treated IOIS integration as a key variable, but have used a diversity of terms such as electronic integration (Venkatraman and Zaheer 1990), EDI integration (Swatman et. al. 1994), application integration (Linthicum 2001), systems integration (Hasselbring 2000) or e-business integration (Markus 2000) to refer to the IOIS integration concept. We argue that the concept of IOIS integration is still ambiguous and lacks an understanding on its nature. The purpose of this paper is to review prior uses of the IOIS integration concept in IS research aiming to present what has been done, and uncover areas for future research (Webster and Watson 2002).

The paper is organized as follows. First, we present how several research IS domains conceptualize systems integration. Next, the research design for this literature survey is presented. Then we present the results. Next we discuss the features of the literature survey and propose an agenda for future research. Finally, we conclude by summarizing the findings, the contributions and the limitations of the study.

2 PAST CONCEPTUALIZATIONS OF INTEGRATION

A wide analysis of the IS literature reveals that besides the systems integration area (Hasselbring 2000), there are other research areas that implicitly or explicitly tackle the concept of systems integration (see Table 1).

The extensive research on *IOIS Adoption* has looked at systems integration as a result of adopting the system (Iacovou et. al. 1995) and as determining IOIS use (Hart and Saunders 1997;Hart and Saunders 1998). During the integration the firm alters its business practices (policies, procedures, values) and systems in order to interface with the IOIS (Chwelos et. al. 2001;O`Callaghan and Kauffman 1992).

Research on *IOIS Standard development* (Damsgaard and Truex 2000;Gosain et. al. 2003;Graham et. al. 2003) considers that the existence of standards as a precursor to systems integration. Thus integration is dependent on the existence of standards.

The *ICT business value* literature treats systems integration as an independent variable leading to higher value for the organization (Barua et. al. 2004;Mukopadhyay and Kekre 2002). What delivers value is not just the ICT artefact but also the ICT-related organizational components (i.e. integrated ICT architecture and processes) (Bharadwaj 2000;Melville et. al. 2004;Zhu et. al. 2004).

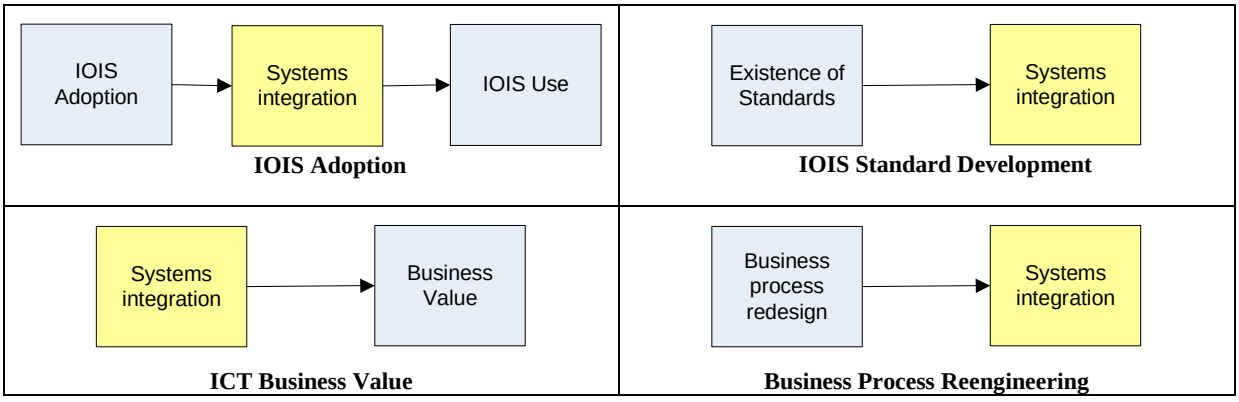
Similarly, *Business Process Reengineering* literature (Brousseau 1994;Davenport and Short 1990;Hammer 1990) argues that ICT connectivity alone is not sufficient to generate value for the organizations and organizational changes in the form of process changes are necessary. Once processes are redesigned ICT may be used to support those intra- and inter-organizational processes. Therefore, integration –consisting of ICT and data integration- can be interpreted as following the redesign of business processes.

The *supply chain* domain views systems integration –consisting of ICT and data integration- as an antecedent to supply chain integration –integration of the activities both inside and outside of an organization- (Fawcett and Magnan 2002;Lee 2000;Simchi-Levi et. al. 2000;Spekman et. al. 1998) or business process improvement (Bhatt 2000). The *supply chain* domain looks at the integration of key business processes from end user through suppliers that provide products, services, and information to the focal firm (Lee 2000;Rai et. al. 2006;Simchi-Levi et. al. 2000). More intensive supply chain integration might result in higher levels of supply chain performance and effectiveness, even though it may also increase the dependencies between the organizations which have made relationship specific investments (Lee 2000;Muckstadt et. al. 2001;Spekman et. al. 1998).

Research on *mergers and acquisitions* (M&A) has also focused on the integration of information systems (McKiernan and Merali 1995;Robbins and Stylianou 1999;Stylianou et. al. 1996). These researchers regard systems integration as a relevant phase of the merger process which precedes M&A success or failure.

Another group of researchers views the interaction of different systems as a conversation between these systems. Communication is not just transformation of information (or data flows), it is also action. Hence these researchers analyse the communication within and between organizations by decomposing it into basic communicative actions. This line of research called *Language Action Perspective* (Goldkuhl and Lind 2002;Kimbrough and Moore 1997;Weigand et. al. 1998) is guided by the theory of communicative action (Habermas 1984) and speech act theory (Searle 1969).

Finally, some researchers theorize about the development of *information infrastructures* (Hanseth 2002;Star and Ruhlender 1996) which define as a shared, evolving, heterogeneous installed base of IT capabilities based on standardized interfaces. These authors view the information infrastructure as the result of an evolving process where heterogeneous IT artefacts become integrated into complex socio-technical systems (Hanseth and Lyytinen 2004).



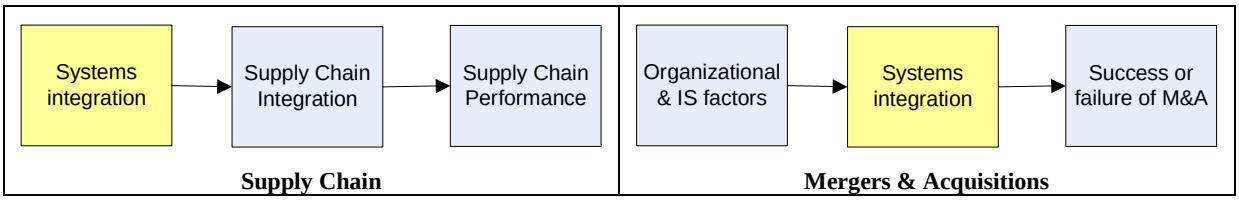


Table 1: Past conceptualizations of systems integration

3 RESEARCH PROCEDURE

3.1 Sampling

To support our analysis, we use the published research literature that tackles the issue of integration. The initial set of articles was identified by a combination of keyword search at EBSCO and Proquest. The keyword used was "integration". Next we read the abstracts to reject those articles that did not explicitly tackle the systems integration concept. In this step we chose new papers that were referred in the initial list and that comply with our selection criteria. We have finally analysed 61 papers.

The journals included are: European Journal of Information Systems (3), Journal of Information Technology (3), International Journal of Electronic Commerce (2), MIS Quarterly (8), Information Systems Research (1), Management Science (2), ACM Transactions on Information Systems (1), Journal of Management Information Systems (4), Communications of the AIS (2), Decision Sciences (2), Journal of Organizational Computing & Electronic Commerce (1), Journal of Strategic Information Systems (1), The Database for Advances in Information Systems (1), Communications of the ACM (7), Electronic Markets (1), Information & Management (7), Information Systems and e-Business Management (2), Journal of Enterprise Information Management (3), Benchmarking: An International Journal (2), Business Process Management Journal (2), Information Technology and Management (1), International Journal of E-Business Research (1), International Journal of Operations & Production Management (1), International Journal of Physical Distribution & Logistics Management (2), and Journal of Business Logistics (1).

3.2 Coding

In the next step we chose the dimensions that would guide our analysis. For this purpose we created two groups of dimensions: 1) those that concern the paradigmatic and methodological issues (Orlikowski and Baroudi 1991) of IOIS integration research, and 2) those that concern the integration construct.

The dimensions we chose to analyse the paradigmatic and methodological issues were:

1. The underlying *epistemology* that guided the research: positivist, interpretative, and critical studies (Orlikowski and Baroudi 1991). Positivist studies assume the existence of a priori relationships and try to investigate them. They can be grounded on existing theory or descriptive. In contrast, interpretive studies assume people create and associate their own subjective and inter-subjective meanings as they interact with the world around them. Interpretive research rejects the possibility of an objective or factual account of events and situations. Finally, critical studies "aim to critique the status quo, through the exposure of what are believed to be deep-seated, structural contradictions within social systems, and thereby to transform these alienating and restrictive social conditions" (Orlikowski and Baroudi 1991).
2. The underlying *theory* or the theoretical perspective that the researchers used for the data analysis.

3. The *research approach* used: laboratory experiment, field experiment, survey, case study, conceptual, field study, review (Orlikowski and Baroudi 1991).
4. The *duration of the study*. We use the four categories: one-shot cross-sectional (data is collected through one snapshot at a particular point in time), cross-sectional over multiple time periods (involves more than one single data-collection period), longitudinal (the study evolves over an interrupted period of time and focuses in process), and process traces (the study is conducted as various time periods to examine how a phenomenon evolves at various time periods) (Orlikowski and Baroudi 1991).
5. The *conceptual model* which concerns the logical formulation of the theoretical argument (or the nature of the relationship between elements identified as antecedents and those identified as outcomes). We build on (Markus and Robey 1988) who distinguish between variance (or factor) and process theories. Variance theories provide explanation for phenomena in terms of relationships between independent and dependent variables. The outcome will occur when necessary conditions are present. In contrast, process theories provide explanations in terms of sequence of events, activities and choices leading to an outcome. Outcomes may not occur when conditions are present.
6. The *unit of analysis* of the phenomenon. In this case we consider four levels: 1) the business unit or division (usually IOIS integration initiatives are initiated at the business unit level); 2) the firm (integration within the firm or between firms but being the focus the firm); 3) the dyad (there is integration between two firms and the research considers the dyad); 4) the network level (integration takes place within a network of firms and the research examines not only the firm and the dyad, but also the network).

The dimensions we chose that concern the integration construct were:

1. The *scope* of integration. Traditionally, literature on systems integration differentiates two types of integration: internal (integration among internal systems in an organization) and external (integration between systems external to an organization with the internal systems of the organization) (Hamilton 1999;Markus 2000;Themistocleous and Irani 2002). In this review we split the external integration into: interface and network integration. Interface integration refers to the adaptations an organization makes to its internal systems in order to allow them interoperate with systems external to the organization (i.e. the level of automation in the information transfer). On the other hand, network integration deals with the connection of systems that belong to different organizations (i.e. type of electronic connection, the existence of standards for processes and data at the network level). Network integration may be located beyond the organization's boundaries.
2. The *layer of integration*: ICT, data and process. Integration at the ICT concerns with the provision of a seamless mechanism for the transmission, processing and storage of information (Markus 2000). ICT layer integration can be achieved through ICT standards (i.e. TCP/IP), web services, message brokers, etc. Integration at the data layer concerns with the availability of common data definitions that enable different systems to process data in real-time, share and automate information exchanges (Goodhue et. al. 1992). Data layer integration can be accomplished through data standards (i.e. EDIFACT, ANSI), normalized data models, XML, etc. Integration at the process layer refers to the extent to which discrete business tasks conducted within or between organizations, are viewed, operated and managed as a unified business process (Markus 2000). The aim is to enhance automation and non-redundancy of business tasks (Hammer 2001), and allow real-time coordination and pragmatic integration (the message transmitted is not only understood by the receiver but also triggers some actions) (Österle et. al. 2001). Some mechanisms that enable process-layer integration are: process standards (i.e. CIDX, RosettaNet) and business process reengineering.

3. The *conceptualization of the ICT artefact*. In analyzing how the ICT artefact has been conceptualized we build on (Orlikowski and Iacovou 2001) who identified five general views: tool (or feature), proxy, ensemble (or functional), computational and nominal.
4. Additionally we also examine the definitions and operationalizations for the IOIS integration construct.

4 RESULTS

4.1 Analysis of methodological issues

Forty four papers (or 73%) were empirical. Within these empirical papers the research approaches that emerged from the analysis were: 22 (35%) case studies, 20 (32%) surveys, 2 (3%) action research, and 2 (3%) field experiments. Two papers (Clark 2001;Fawcett and Magnan 2002) combined case study and survey studies. Three of the case studies (Crook and Kumar 1998;McAdam and McCormarck 2001;Volkoff et. al. 2005) used grounded theory, and one of the survey studies (Daniel and White 2005) used the delphi method. Within the 17 (or 27%) non-empirical papers 15 (24%) were conceptual and 2 (3%) did a review (Al-Naeem et. al. 2004;Themistocleous and Irani 2001) of existing literature.

Positivism was the dominant epistemology with 53 papers (or 86%). Twenty six articles (42%) were theory grounded and 27 (44%) were descriptive. There were 8 (13%) interpretive studies and none adopted a critical perspective. Table 2 shows the breakdown of papers by research approach and epistemology.

	Case study	Survey	Conceptual	Action research	Review	Field experiment
theoretically grounded	6	13	4	1	0	2
descriptive	8	7	11	1	2	0
interpretativist	8	0	0	0	0	0
critical	0	0	0	0	0	0

Table 2: Frequency of research approaches for each epistemology

Prior research has drawn on the following theoretical perspectives: transaction cost theory (12 times), resource-based theory (3), semiotics (2), information processing theory (7), organizational theory (2), IS implementation (1), inter-organizational relationship (3), resource-dependence theory (2), diffusion of innovations (4), institutional theory (1), roles-linkage model (1), communities of practice (1), business process reengineering (2), industrial organization (1), game theory (1) and technology-organization-environment framework (1).

The duration of the empirical studies has been: 30 (or 48%) papers used one-shot cross sectional data collection, 7 (11%) papers used cross-sectional over multiple periods, 8 (13%) were longitudinal studies and 1 (2%) was categorized as process trace. Table 3 shows the breakdown of papers by research approach and duration. All but two (Bergeron and Raymond 1997;Christiaanse and Venkatraman 2002) of the 20 survey studies, of the two action research studies and of the two field experiment studies used one-shot cross-sectional data collection or cross-sectional data collection over multiple periods. On the other hand, the case studies used a combination of one-shot cross-sectional, multiple cross-sectional, longitudinal and process traces studies.

	Case study	Survey	Conceptual	Action research	Review	Field experiment
one-shot cross-sectional	13	16	0	1	0	2
cross-sectional over multiple time periods	3	3	0	1	0	0
longitudinal	6	2	0	0	0	0
process traces	1	0	0	0	0	0
NA	0	0	15	0	2	0

Table 3: Frequency of research approaches for the research duration

Finally, within the empirical papers the most common unit of analysis has been the firm (37 times), followed by the dyad (16 times), the business unit (8) and the network (5). On the other hand, 28 of the empirical have adopted a variance model and 16 have adopted a process model.

4.2 Analysis of concept

Fifteen papers (or 24%) provided some definition for integration. However, these papers used diverse terms for integration: systems integration, electronic integration, EDI integration, data integration, B2B application integration. Integration has been defined from several perspectives (see Table 4): 1) as process, 2) as use, 3) as strategy, 4) as structure, 5) as degree, 6) as a set of tools, or 7) as automation.

Perspective	Definition
Process	· EDI integration "is the process during which a firm alters its business practices and applications so that they interface with its EDI applications." (Iacovou et. al. 1995):468 · Systems integration "is the creation of tighter linkages between different computer-based information systems and databases" (Markus 2000):10
Use	· Data integration is "the use of common field definitions and codes across different parts of the organization" (Goodhue et. al. 1992)
Strategy	· Electronic integration are "the strategic choices made by a firm to exploit ICT to transform business processes and relationships, and business networks" (Kambil and Short 1994).
Structure	· Systems integration is "the structural coherence of a set of applications and databases. Structural coherence can be achieved through the adoption of common data, process and technology definitions." (Hamilton 1999):70 · Electronic integration is a "form of vertical quasi-integration achieved through the deployment of proprietary information systems between relevant actors in the adjacent stages of the value-chain" (Zaheer and Venkatraman 1994):549.
Degree	· Information systems integration is "the extent to which a firm integrates its various IT systems to provide visibility to customer and supplier data and to allow online information sharing and transaction execution across the value chain. It is achieved by resolving data type and semantics differences among multiple databases and integrating various hardware platforms, communication technologies and applications to works seamlessly" (Barua et. al. 2004):593 · Information systems integration is "the extent to which data and applications through different communication networks can be shared and accessed for organizational use." (Bhatt 2000):1333 · EDI integration is "extent to which data could be directly entered into internal applications without additional preprocessing." (Lee and Lim 2003) · "The degree to which a focal firm has established information systems for the consistent and high-velocity transfer of supply chain-related information within and across its boundaries" (Rai et. al. 2006).
Set of tools	· B2B Application Integration are "the mechanisms and approaches to allow partner organizations…to share information in support of common business events. In short, B2B application integration is the controlled sharing of data and business processes among any connected applications and data sources, intra- or inter-company." (Linthicum 2001):10, also

	used by (Themistocleous and Irani 2001;Themistocleous and Irani 2002).
Automation	· External systems integration refers to the "IT-mediated transactions between independent business entities" (Markus et. al. 2003)

Table 4: Integration perspectives

A common feature of the definitions above is that they deal with the three layers of integration (ICT, data and process) proposed in the coding section. Fifty four papers deal with integration at the process layer, 42 at the data layer, 42 at the ICT layer, and 29 consider the three layers simultaneously.
Analysis of former literature reveals three scenarios for IOIS integration at the data layer:

1) The creation of a unique shared repository for data, which will avoid data redundancy, and the problems of asynchronous data exchange between different systems (Volkoff et. al. 2005). This is similar to the global schema approach (March et. al. 2000).
2) Data are standardized, but they are stored in several repositories. As different systems may have the same data there may be data-redundancy. This scenario fits into the federated schema approach (Sheth and Larson 1990).
3) Data are not standardized, and they are stored in several repositories. Data are transformed (syntactically) and synchronized from one application to another. Each system has its own data schema. This scenario also fits into the federated schema approach (Sheth and Larson 1990).

Similarly, prior literature uses two forms of IOIS integration at the process layer:

1) Communication among business tasks that compromise the inter-organizational business process and among agents who operate and/or manage the business tasks (Becker et. al. 2003;Kobayashi et. al. 2003;McAdam and McCormarck 2001).
2) Coordination of the business tasks spanning several organizations, or the creation of tighter coordination among discrete business activities conducted by different organizations, so that a unified business process is formed (Kemppainen and Vepsäläinen 2003;Markus 2000;Sikora and Shaw 1998).

Apart from the ICT, data, and process layers, prior literature has used additional ones. Lee et al. (2003) propose behavioural integration, which deals with the "redistribution of roles and responsibilities among members which can destroy an organization if it is not properly managed". The authors argue that change management and transformation of an organization are difficult and sensitive issues in any integration project. Waring and Wainwright (2000) classify the definitions of integration into four areas: technical, systems, organizational and strategic. The authors acknowledge that focussing on the technical aspects of integration at the expense of human and organisational aspects may compromise success, particularly as the concept of integration is open to a range of interpretations. In a multi agent context Sikora and Shaw (1998) decompose integration into three layers: 1) integration of heterogeneous information systems, data bases, or application software, which fits with the data and ICT layers; 2) integration of different physical stages in business processes to improve the internal performance metrics, which fits with the process layer; and 3) a higher- layer dimension which is the integration of subsystems into a well-coordinated, networked system.

Forty eight papers deal with interface integration, 43 with internal integration and 14 with network integration. Nevertheless 7 deal with the three simultaneously, and only 3 of these papers are empirical.

Most studies in the sample (35 or 56%) conceptualize the ICT artefact as a tool. The rest of studies adopt: 14 (23%) a proxy view, 7 (11%) an ensemble view, 2 (3%) a computational view and 4 (6%) a nominal view.

Some studies have treated integration as a dependent variable and have examined its antecedents, whereas others have studied the consequences of IOIS integration. Figure 1 depicts a list of antecedents and consequences of integration that appears in the literature.

Antecedents	Consequences
• supply chain interdependence, demand uncertainty and product complexity (Kim and Umanath 1999) • business process compatibility, adaptability of business processes, leveraging legacy assets, support for business transactions, and network security services (Yang and Papazoglou 2000) • business process asset specificity, trust (Zaheer and Venkatraman 1994) • type of relationships between units, data definitions, business process, business unit objectives, time horizons, level of data detail, relative focus of timeliness versus accuracy (Volkoff et. al. 2005) • customer support, competitive pressure, internal management support, expected/realized benefits, compatibility of EDI, resource intensity of EDI (Ramamurthy et. al. 1999) • existence of standards (Gosain et. al. 2003; Bhatt 2000) • partners trust, interdependence and commitment (Lee and Lim 2003). • data timeliness requirements and the expected number of transactions (Schwinn and Schelp 2005) • degree of interdependence of business units (Gattiker and Goodhue 2005) • speed of communication, unambiguous and uniform exchanges, and reciprocal interdependence (Hart and Estrin 1991) • high internal integration may create propensity for implementing high interface integration (Truman 2000)	• direct, first-order, operational benefits (automation of daily processes and cost reduction) (Bergeron and Raymond 1997;Iacovou et al. 1995; Mukopadhyay and Kekre 2002) • indirect, second-order and strategic benefits (accrued over an extended period of time, is associated with improved partner relations, increased flexibility and responsiveness (Bergeron and Raymond 1997; Iacovou et al. 1995; Mukopadhyay and Kekre 2002) • comparative advantage (Swatman et. al. 1994) • new dependencies/vulnerabilities, improve organizational coordination (Hart and Estrin 1991) • alteration of the nature of relationships, increase in performance (in the dimension new business) (Venkatraman and Zaheer 1990) • organizational performance and market performance (Ramamurthy et al., 1999) • higher level of customer-side and supply-side online informational capabilities (Barua et al. 2004) • supply channel performance (Kim and Umanath 1999) • e-business value (Zhu et al. 2004) • JIT product creation and the performance of an organization's logistics and distribution (Srinivasan et al., 1994) • consequences of poor integration: "classic boom-bust bullwhip of materials tricking down the supply chain and alternating excess inventory and stock-outs." (Frohlich, 2002)

Figure 1: Antecedents and consequences of integration

Similar to the definition of systems integration (Table 4), we notice a lack of consensus on the measurement of the IOIS integration construct. Table 5 summarizes the diversity of measures for IOIS integration that the prior literature has used. There are two main group of measures: 1) those concerning the object of integration (the transaction, the data, the application, process or business function, and the partners), and 2) those referring to the degree of automation.

Measures	Measurement	Authors
Transaction		
Volume	・Total number of documents handled through EDI in relation to the total number of documents ・% of a firm's business directed to the focal firm through an IOIS (usually proprietary)	(Christiaanse and Venkatraman 2002;Massetti and Zmud 1996;Zaheer and Venkatraman 1994)
Intensity	・% of data exchange volume facilitated by each transaction type	(Krcmar et. al. 1995;Truman 2000) (Lee and Lim 2003)
Diversity	・Number of distinct transaction sets a company handles through EDI with its trading partners	(Lee and Lim 2003;Massetti and Zmud 1996;Premkumar and Ramamurthy 1995;Ramamurthy et. al. 1999)
Data		
Compatibility	・Ease with which data from different systems and organizational functions can be shared	(Goodhue et. al. 1992)
Accessibility	・Visibility of customer orders throughout the organization (interconnectedness) ・Single capture of information	(Hasselbring 2000) (Truman 2000)
Application, process or business function		
Integration of functions	・Variety of applications (or business functions) interconnected through EDI (or any other electronic link)	(Bergeron and Raymond 1997) (Iacovou et. al. 1995) (Massetti and Zmud 1996)
Partners		

Integration with partners	· Number or % of trading partners with whom the organization interacts through EDI (or any electronic link) · Direction of integration with partners: backward, forward	(Bergeron and Raymond 1997) (Fawcett and Magnan 2002) (Fearon and Philip 1999) (Iacovou et. al. 1995) (Massetti and Zmud 1996) (Premkumar and Ramamurthy 1995) (Tuunainen 1998) (Williams et. al. 1998)
Degree of automation		
Depth or Degree of integration	· Degree of electronic consolidation that has been established between business processes of two or more trading partners: 1) file-to-file, 2) application-to-application, and 3) coupled work environment. · % of internal data processing done through EDI in relation to manual processing · Degree of integration between the IOIS and the firm's internal systems: 1) loose vs. tight integration (dichotomous scale), 2) 7-point Likert-type scale	(Chatterjee et. al. 2002) (Fearon and Philip 1999) (Iacovou et. al. 1995) (Krcmar et. al. 1995) (Massetti and Zmud 1996) (Ramamurthy et. al. 1999) (Subramani 2004) (Swatman et. al. 1994) (Themistocleous and Irani 2002) (Truman 2000) (Tuunainen 1998) (Williams et. al. 1998) (Lee and Lim 2003) (Premkumar and Ramamurthy 1995)

Table 5 : Measures of IOIS integration

5 DISCUSSION

There are several points to draw from the analysis of the results in the previous section, which we propose as areas to uncover in future research:

1. We regard IOIS integration as a multidimensional concept whose relevant dimensions will vary across contexts. We propose IOIS integration involves four dimensions: 1) the scope (internal, interface and network); 2) the layer (process, data and technology); 3) the set of systems that constitute the IOIS (the features of these systems); and 4) the business network characteristics: topology (i.e. dyadic relationships, hub-spoke), the mode of interaction (i.e. equal or hierarchical interactions) and the interdependence between network members (i.e. pooled, sequential, reciprocal). We observe that most of the operationalizations in Table 5 use lean measures for IOIS integration that partially consider a maximum of two dimensions: the layer (or object) and the business network topology. Moreover, these measures are closer to IOIS usage (Massetti and Zmud 1996) than to integration. Likewise, the measures for the degree of automation are treated as dichotomous. Any study that attempts to operationalize IOIS integration should contextualize the measures; hence researchers should first choose the adequate dimensions according to the context, and secondly define appropriate measures for each dimension.
2. In this literature survey we observe a large number of papers that view integration as being materially determined. They consider that recent ICT developments (i.e. web services, XML) will promise the ability to easily integrate across traditional organizational boundaries, as they reduce the relationship-specific investments required (Christiaanse et. al. 2004) and make syntactical interoperability easy (Park and Ram 2004). Drawing on Iivari's (2003) three levels of abstraction in any information system or IOIS (organizational level, conceptual/infological and datalogical/technical level) we observe that the technical level of IOIS integration is relatively well covered by existing research, whereas few research has worked on the other two levels. The real challenge of integration does not only lay within the technical realm, but in the socio-technical realm (Waring and Wainwright 2000). This implies that examining the organizational and conceptual levels as well as adopting an ensemble view of the artefact may be suitable in the analysis of IOIS integration. In line with this perspective, theoretical lenses such as actor-network theory (Walsham 1997), which examine the interplay between the social and the technical by making no analytical distinction between them, seem adequate.

3. Integration is not a new phenomenon, especially within the organizational boundaries. Although existing literature on enterprise systems implementation and integration is a useful departure point for the examination of integration, IOIS integration has some particularities that cannot be fulfilled by prior literature. These particularities are: 1) firms are autonomous entities that do not operate on data and processes shared between them (Bussler 2003), 2) the number of actors (humans and non-humans) involved in inter-organizational context is larger than within organizations. In addition, the multiple interests and viewpoints of the stakeholders, the way these interests and viewpoints evolve, as well as how the stakeholders are interrelated (Pouloudi et. al. 2004) may shape the integration process; and 3) in inter-organizational contexts there is not always a higher authority that orchestrates the relationship (Markus 2000).

4. A great deal of prior literature is based on the assumption that IOIS integration deterministically implies organizational and inter-organizational results (Barua et. al. 2004;Bergeron and Raymond 1997;Mukopadhyay and Kekre 2002). In line with this assumption, some researchers conceptualize integration as a set of stages with increasing integration indicating more maturity, more control, and more efficiency (Angeles and Nath 2000;Clark 2001;Swatman et. al. 1994). Integration efforts, however, are prone to bring surprises to organizations as integration may indeed produce rather than curb disorder (Ellingsen and Monteiro 2005). Thus, there has been a call for an exploration of issues such as side effects (Jacucci et. al. 2003), disintegration, reverse integration and the unpacking of integrated systems (Lamb 2003).

5. Previous research has mainly conceptualized integration as an event, not an ongoing process, and therefore it has applied one-shot cross-sectional data collection (48%) and analysis. However, integration does not come quickly to information systems, which have been built up over years by layering new generations of technology or data models on top of old ones. IOIS integration is expected to be a cumulative process and to become path dependent in the sense that existing systems will influence the integration choices and paths (Hanseth 2002). Separate information systems become integrated over time into complex ensembles of heterogeneous IT artefacts, which are increasingly connected with and dependent upon one another (Hanseth and Lyytinen 2004). In line with this process view of IOIS integration, mutual adaptation theory (Leonard-Barton 1988;Orlikowski 1996) seems appropriate to inform integration research. Mutual adaptation theory can be used to examine the actions taken by different actors to appropriate the ICT features, modify their working procedures, their organizational structures or their communication patterns as a result of integration, and on the other hand, to examine how the artefact is altered.

6. Most of the prior research on integration focuses on transactional interactions within firms as well as between firms such as customers and suppliers in the value chain. There is a lack of papers, Lamb (2003) is an exception, that deals with integration of systems that are not transactional.

7. Finally, this literature survey confirms Kambil et al.'s observation (Kambil and Short 1994) that there is little empirical research at the network level (5 times).

The areas for future research we have proposed have consequences on the type of research methods and designs to be used for the analysis of IOIS integration. First, due to issues such as path dependency, doing research on IOIS integration entails adopting a process model, rather than a variance model (Markus and Robey 1988). Second, conceptualizing integration as a process leads to the collection of data using multiple timeframes. Finally, in the early stages of the research, qualitative data sets might be useful to frame the context (i.e. industry, stakeholders involved, type of inter-organizational relationship, type of IOIS) and obtain the salient characteristics of integration in that context. A qualitative research approach would enable inductive theory building. Furthermore, we advocate for contextual studies, and hence interpretive research would give access to the subjective understandings and meanings attributed by actors as well as provide contextual explanations for IOIS integration.

6 CONCLUSIONS

This paper shows that even though IOIS integration has been extensively used in the IS literature, the IOIS integration construct has received little conceptual scrutiny and has been marked by the diversity of conceptualizations. This diversity in IOIS integration research is manifested in the variety of terms and dimensions used, the variety of meanings (interfacing, adoption, implementation or use) attributed, the scarcity and disparity of dimensions considered and the variety of research methods adopted. This essay has attempted to show how: 1) different IS domains conceptualize integration; and 2) how systems integration literature has tackled the concept, both from a methodological point of view as well as from a conceptual perspective. We do not perceive the diversity of conceptualizations as a problem; we consider any conceptualization is context-specific. We regard IOIS integration as having four dimensions: scope, layer, set of systems, business network characteristics (topology, mode of interaction and interdependence). Any attempt to operationalize IOIS integration may select the appropriate dimensions for the context of the research and define measures for each dimension.

This study suffers from a few limitations. First, our selected sample could possibly have been expanded. Second, we could have been used additional dimensions for the analysis of the research methodology and the construct. Finally, a further literature review might consider the context of the empirical papers (type of IOIS, industry, country, etc). This paper contributes to the literature on integration by identifying methodological and conceptual aspects of this concept as well as by proposing areas for future research.

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Appendix 2

Rodon, J., Pastor, J. A., and Sesé, F. (2007), "The Dynamics of an IOIS in the Seaport of Barcelona: An ANT Perspective", in IFIP International Federation for Information Processing, Volume 235, Organizational Dynamics of Technology-Based Innovation: Diversifying the Research Agenda, eds. McMaster, T., Wastell, D., Ferneley, E., and DeGross, J. (Boston: Springer), pp. 297-314.

20 THE DYNAMICS OF AN IOIS IN THE SEAPORT OF BARCELONA: An ANT Perspective

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Abstract *On the basis of a longitudinal interpretive case study, this paper explores the dynamics in the implementation of an industry interorganizational information system (IOIS). The paper covers 11 years (1994–2005) of the implementation process. We use the lens of actor network theory (ANT) to analyze the process of emergence, development, and progressive stabilization of a socio-technical network, that of the IOIS. We focus on the negotiations and translation of interests that occur during the implementation of the IOIS. By using ANT we develop a different reading of the implementation process, which we believe provides a holistic view of the implementation, and can be adapted and applied to similar implementation projects. ANT is suitable as it helps us trace the course of the implementation, and because of the nature of the IOIS and of the implementation process, which involves political negotiations.*

Keywords Interorganizational information system, standard, implementation, actor network, case study

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1 INTRODUCTION

The research presented in this paper is based on a longitudinal case study about the implementation of an industry interorganizational information system (IOIS) for the exchange of documents in the landside transport network of the seaport of Barcelona. Borrowing the concept of information infrastructure from Hanseth and Lyytinen (2006), this paper defines an industry IOIS as a shared, evolving, and heterogeneous installed base of IT capabilities built on standardized interfaces. An IOIS is shared in the sense that it is set up, organized, and used by firms in the same industry. It evolves as new companies integrate with it or as new types of exchanges become possible through the IOIS. An IOIS is not designed from scratch; the existing installed base has an inertia that influences the way the IOIS is designed. It is heterogeneous as it encompasses multiple technologies as well as non-technological elements (social, organizational, institutional, etc.) that are necessary to sustain and operate the IOIS. Finally, an IOIS usually embeds and supports data and process standards that are defined by the same industry actors (Markus et al. 2006).

Drawing upon actor network theory (ANT), we inquire into the interplay among diverse actors (public bodies, private organizations, artefacts, procedures, standards, etc.) during the emergence, development, and stabilization of the IOIS. ANT allows us to describe in detail how the large heterogeneous actor network that represents an IOIS is built. We contribute to the literature on IOIS: first, we examine both IOIS development and diffusion; second, we focus on an industry phenomenon, thus our outcome of explanation is at the industry level of analysis; and finally, we extend prior literature on IOIS at seaports by using the lens of ANT to analyze the process that leads to the progressive stabilization of an IOIS.

We first give an overview of the role of IOIS in seaports and the use of ANT in IOIS literature. This is followed by an introduction to the research approach. Next we present the analysis and interpretation of the case study. Finally, we discuss the results of the case and present concluding remarks.

2 LITERATURE REVIEW

2.1 Seaports and IOISs

A seaport is an interface between a sea transportation system on one side, and a land transport network on the other side. Whereas the shipping industry has developed standard procedures for the seashore interface, the development of land transport has been shaped by the local regulatory and organizational framework.

In the landside transport network, companies operate in different roles including port authority, shipping agents, terminal operators, stevedores, harbor master, freight forwarders, customs, rail/truck carriers, pilots, haulers, and clearing agents. There are two forms of interactions in the transport network: (1) operational interactions related with the physical transfer of cargo and (2) administrative interactions related with the supervisory and information based exchanges. Each member in the transport network operates as a supplier as well as a customer, and generates some kind of information that is to be

transferred along the network (van Baalen et al. 2000). Traditionally, administrative interactions have been highly paper-intensive. Therefore, from a technical-economic perspective the standardization, rationalization, and automation of these interfirm data exchanges with IOISs may enhance the efficiency of the entire transport network (McMaster and Wastell 2005).

Prior research on IOIS in seaports has examined a diversity of topics: the transformation of the organizational efficiency and effectiveness that results from the development of the IOIS (Teo et al. 1997), the political and economical models of port communities (Wrigley et al. 1994), the implementation process and decision to adopt the IOIS (van Baalen et al. 2000), and the role of trade associations in the diffusion of the IOIS (Damsgaard and Lyytinen 2001). These studies have been informed by transaction costs theory, diffusion of innovations theory, and institutional theory, but they have scarcely focused on the socio-technical nature and longevity of the IOIS implementation, which is an aim of this paper. In order to fill this gap, we use ANT.

2.2 Implementation of IOISs through the Lens of ANT

Through the lens of ANT, the implementation dynamics of an IOIS may be regarded as the emergence, development and stabilization of an actor network. ANT assumes that the boundaries between the social and the technical can always be contested. Thus an IOIS may be viewed as a stabilized set of relations between humans and nonhuman artefacts (e.g., computers) and rules (e.g., laws, policies). ANT pays attention to the interplay between diverse human and nonhuman actors: how the diverse actors' interests are translated and inscribed into technical artefacts, and how actors form alliances in order to mobilize support (Walsham 1997). To create a stable system, the actors must be aligned. If such alignment does not occur, the system will not survive.

ANT is suitable to study the implementation of IOIS for the following reasons. First, ANT helps explore how actor networks are formed, hold together, or fall apart. Thus, it supports our emphasis on the process aspect of implementation. Secondly, since the nature of IOIS implementation is a political-negotiating process, ANT provides an analytical framework for studying power processes within a socio-technical context. Finally, given the evolving nature of IOIS, ANT is appropriate because it distances itself from the view that technologies are stable entities that are passed from community to community and then put into use (McMaster et al. 1997). Next we present the concepts from ANT that will be used in this paper.

2.2.1 Translation

ANT treats humans and artefacts as a single heterogeneous unit of analysis—an actor network—and translation refers to the way in which this network is formed. Translation means reconciling the different meanings that actors hold of a given phenomenon. During translation, actors negotiate or maneuver others' interests toward their own with the aim of enrolling actors into the network. Thus, the translation process has political implications: "The result [of translation] is a situation where certain entities control others. Understanding power relationships means describing the way in which actors are defined, associated and simultaneously obliged to remain faithful to their alliances"

(Callon 1986, pp. 224). For instance, within the context of IS development, during the process of translation actors interact with each other to work out a scenario of how the system will work and will be used. "To translate is to displace…[and] to express in one's own language what others say and want, why they act in the way they do and how they associate with each other: it is to establish oneself as a spokesman" (Callon 1986, p. 223). The process of translation goes through four moments: problematization (problem formulation), interessement, enrolment, and mobilization (Callon 1986).

- During problem formulation, an actor frames a problem or an opportunity and attempts to persuade other actors in the network that the problem/opportunity is worthy of having resources dedicated to it. It is crucial to find a solution that is of common interest for the participating actors, despite their diverse interests. Problematization culminates with the definition of a point—namely, an obligatory passage point—through which any actor with a stake in the network has to pass in order to attain its objectives.
- Interessement means that other actors become interested in the solution proposed. They change their affiliation to a certain group in favor of the new actor. "For all the groups involved, the interessement helps corner the activities to be enrolled. In addition, it attempts to interrupt all potential competing associations and to construct a system of alliances" (Callon 1986, p. 211). If interessement is successful, it confirms the validity of problematization.
- Enrolment concerns "the group of multilateral negotiations, trials of strength and tricks that accompany the interessements and enable them to succeed" (Callon 1986, p. 211). Latour (1987) suggests five strategies for enrolment: (1) cater to others' interests; (2) convince others that their usual ways are cut off; (3) to seduce them through a detour; (4) reshuffle interests and goals (displacing goals, inventing new groups or new goals, rendering the detour invisible, winning trials of attribution); and (5) become indispensable to others.
- Mobilization is about stabilizing the actor network by making durable and irreversible relations. The network results in a single actor, which can be treated as a black-box (Latour 1987, pp. 131).

2.2.2 Inscription

Inscription is the process whereby translations of one's interests are embodied into technical artefacts. That is, a translation presupposes a material into which it is inscribed: text, software, skill, etc. The inscription includes programs of action for the users, and it defines roles to be played by users and the system. When a program of action is inscribed into a piece of technology, the technology becomes an actor imposing its inscribed program of action on its users. Inscriptions vary in terms of (1) what is inscribed: which anticipations of use are envisioned; (2) how are these anticipations inscribed: what is the material for the inscriptions; (3) who inscribes them; and (4) the strength of the inscriptions: how much effort does it take to oppose an inscription (Monteiro 2000, pp. 79). "The strength of inscriptions, whether they must be followed or whether they can be avoided, depends on the irreversibility of the actor network into which they are inscribed" (Monteiro 2000, pp. 78).

Table 1. **Set of Concepts of Actor Network Theory**

Concept	Definition
Problematization	Process of alignment of the interests of a set of actors with those of a focal actor.
Interessement	Second moment of translation in which other actors become interested in the solution proposed. They change their affiliation to a certain group in favor of the new actor (Callon 1986).
Enrolment	Third moment of translation that concerns "the group of multilateral negotiations, trials of strength and tricks that accompany the interessements and enable them to succeed" (Callon 1986, p. 211).
Mobilization	Last moment of translation that consists of stabilizing the actor network by making durable and irreversible relations.
Spokesperson	An actor that speaks on behalf of other actors.
Obligatory Passage Point	Moment that is fixed during problematization through which any actor with a stake in the network would have to pass in order to attain its objectives.
Inscription	Process whereby translations of one's interests are embodied into technical artefacts; that is, the way physical artefacts embody patterns of use.
Black-boxing	Process whereby an "assembly of disorderly and unreliable allies is… slowly turned into something that closely resembles and organized whole. When such a cohesion is obtained we at last have a black box" (Callon 1986, p. 131).
Irreversibility	Concept that captures the accumulated resistance of an actor network against change; irreversibility also reflects the strength of inscriptions.

Working on the basis of the concepts presented in Table 1, we explore the implementation of an IOIS in the context of a seaport by tracing how the creation and stabilization of the actor network unfolded.

3 RESEARCH METHODOLOGY

An exploration of the dynamics of IOIS implementation requires us to take a process approach, which typically involves longitudinal analysis. Since our emphasis is on understanding reality in a specific context, we opt to use an interpretive case study (Walsham 1995). This research approach is "aimed at an understanding of the context of the information system and the process over time of mutual influence between the system and its context" (Walsham 1993, pp. 14).

The empirical work was conducted by the first author over three different periods (see Table 2 for a description of periods, topics of inquiry, and informants). We collected data through semi-structured interviews (about 1 hour each), informal conversations, press documents, field site visits, meeting attendance, and meeting minutes. Within each period, data collection and analysis occurred recursively, thus guiding subsequent interviews.

Table 2. **Data Collection Periods, Topics Being Inquired and Informants**

Period	Interviews, Topics of Inquiry, and Periods	Informants
First (October–November 2001)	Number of interviews: 6 Topics: History of the standardization process and the decision to implement the IOIS, and the actors involved Period inquired: 1992–2001	PAB: CIO and IS workers IGC and TelFor: participants IOS CEO and CIO Two adopters of the IOIS: CEOs and CIOs
Second (January–March 2004)	Number of interviews: 10 Topics: Standard development; standardization organization, outcomes, and actors Period inquired: 1998–2004	TelFor: Six participants PAB: CIO and two IS workers Customs: Two managers
Third (March–November 2005)	Number of interviews: 27 Topics: Standard evolution and outcomes; IOIS implementation (design decisions and actions and adopters' actions); problems arising during the integration of preexisting systems with the IOIS Period inquired: 2000–2005	IOIS: CEO, marketing manager, IS consultants, and designers Nine port agents: CEOs, COOs, CIOs, developers, and users

The involved researcher role was adopted (Walsham 1995). Besides attending meetings and presentations, we provided participants with feedback in the form of presentations and reports after each of the three data gathering periods. We considered this feedback useful because: (1) it gave us an in-depth understanding of the phenomenon; (2) it was a way to contrast and validate our interpretation; and (3) it facilitated our subsequent access to the field.

We use ANT as a lens to retrospectively interpret, structure, and present the empirical data through a narrative that reveals how events occur over time. We focus on the implementation of the IOIS throughout its emergence, development, and stabilization. We split the case analysis into five chronological stages, which are chosen in accordance with the researchers' interpretation of the data gathered. We use italics to highlight the ANT terminology in the case.

4 CASE STUDY ANALYSIS

4.1 Stage 1: Emergence of the Standard (1994–1997)

During the early 1990s, within the framework of the elaboration of a quality plan in the port of Barcelona, some of the port agents[1] complained about the response time of

[1]The port agents are shipping agents, inland terminals, freight forwarders, depots, haulers, and clearing agents.

customs clearance and handling of goods at the port. These port agents had always considered that the inefficiencies in the document exchanges were Customs' fault. Customs, for its part, wanted to modernize its services. At that time, the most common mechanisms for document exchange were fax and courier services.

Framing this as a problem with the mechanisms of formal documentary exchange between port agents and public bodies, the Port Authority of Barcelona (PAB) created the Information Guarantee Commission (IGC) at the beginning of 1994 to standardize the document exchange procedures and to define EDIFACT messages for the documents that port agents had to submit to the PAB and Customs (private-to-public exchanges). The PAB thus successfully *translated* Customs' and the port agents' interests. By *enrolling* with the IGC, Customs would modernize its services and improve the response time of customs clearance. Their respective *interests would be realized* by going through the IGC's work in extending electronic data exchange to all the documentary formalities between the port agents and public bodies at the port.

Likewise, the PAB *rendered itself indispensable* for port agents by acting as a one-stop shop with Customs. Port agents (shipping agents) could send electronic messages (e.g., cargo manifests) to the PAB who would forward them to Customs. However, once the procedures and messages defined by the IGC were in place, they were not adopted. Because most of the port agents were small firms and did not have the IT capabilities, the new procedures and messages could not overcome the inertia of the already installed base of fax and courier services as document exchange mechanisms at the port.

4.2 Stage 2: Emergence of the IOIS (1998–1999)

The PAB, in order to overcome the lack of IT capabilities of port agents, then proposed the development of a common IOIS for the entire community in 1997. For the PAB, this IOIS was the *device that would interrupt* the port agents from existing fax and courier services, hence enhancing the adoption of private-to-public exchanges. On the other hand, port agents became *interested* as the IOIS would help them overcome their lack of IT capabilities. A new actor network had *emerged*, one that concerned the creation of the IOIS. The PAB performed a set of actions to keep port agents *interested* in the IOIS.

- In 1998, the PAB governing council dissolved the IGC to form the Telematic Forum (TelFor). TelFor was a standardization committee that would extend the work of the IGC to those processes between port agents—namely, private-to-private exchanges. TelFor's standard dealt with the syntax and semantics of the EDIFACT messages exchanged. TelFor's participants—port agents that were supposed to *speak on behalf* of their trade associations[2]—used a consensus-based approach. By enrolling in TelFor, the port agents had the opportunity to standardize their daily exchanges, which represented savings in their operations.
- The PAB developed a master plan that proposed building an IOIS, namely PortIC (Port Information and Communication System), which would coordinate the activity of firms in the landside transport network of the port and integrate all of the infor-

[2]Associations of shipping agents, clearing agents, port stevedores, and freight forwarders.

mation exchanged among port agents and public bodies. PortIC would implement the standard defined by TelFor, thus offering three types of services: (1) private-to-public exchanges; (2) private-to-private exchanges; and (3) real-time information services that allowed the documentary tracking of goods. The PAB presented PortIC as an opportunity to enhance the efficiency and competitiveness of the port community. As a shipping agent retrospectively observed: "It seemed [that PortIC] would bring a clear productivity increase in our operative model." The PAB invoked the vision of a "paperless port," and PortIC was supposed to *inscribe* this vision.

- The PAB showed port agents the threat of a new entrant if they were not competitive. That is, the PAB *displaced* the port agents' goals. The PAB's CEO stated to the press:

> The control of the information that the transport chain generates is vital to be in the market and we must maintain this advantage. If we lose the control of this information because a third party, whether a shipping company or a financial institution, manages it, our business will be finished.

- For the development of PortIC, a formula of open public tenders was used. The specifications of the call for proposals set a deadline of 6 months. This 6-month deadline was a *strategy* that, although seen as unrealistic, the designers of the system helped the focal actor (PAB) *keep port agents interested* in the IOIS. In September 1998, after the analysis and the evaluation of the tenders' proposals, the project was awarded to a joint venture by two IS consultancies.
- PortIC was conceived to give everyone access regardless of their in-house systems. As most of the firms in the community were users of the Internet, PortIC was Internet-enabled. That was supposed to *interest* port agents as it promised easy accessibility to PortIC. On the other hand, PortIC's designers *interested* the IS workers of those port agents by defining multiple data exchange formats and services (Figure 1). For those who did not wish to integrate the messages with their in-house applications, PortIC developed a standalone Java-based application (FrontEnd) that ran on a PC and could be used to generate and receive messages.
- In 1999, PortIC raised concerns among the potential adopters regarding data security and privacy because PortIC would centralize all information. These concerns were solved by *enrolling new technical actors* into the network and *inscribing certain programs of action*, namely a security policy, into the PortIC system: (1) the legal certainty was guaranteed by means of an electronic data exchange agreement between the parties, taking into account in a company's contract of adherence; (2) those using the FrontEnd application had a smartcard with a digital certificate issued by the Barcelona Chamber of Commerce; (3) messages generated from FrontEnd were encrypted using the SSL protocol; and (4) the PortIC computer system included an electronic certificate issued by the Chamber of Commerce, high availability firewalls, and control of access to the applications.
- Finally, actors *entered into a pact* on how to manage the IOIS once it was developed. In February 1999, the PAB, the trade associations, and the Chamber of Commerce, which represented importers and exporters, set up a company, named PortICCo, to manage the operation of PortIC when completed in May 1999. Actors'

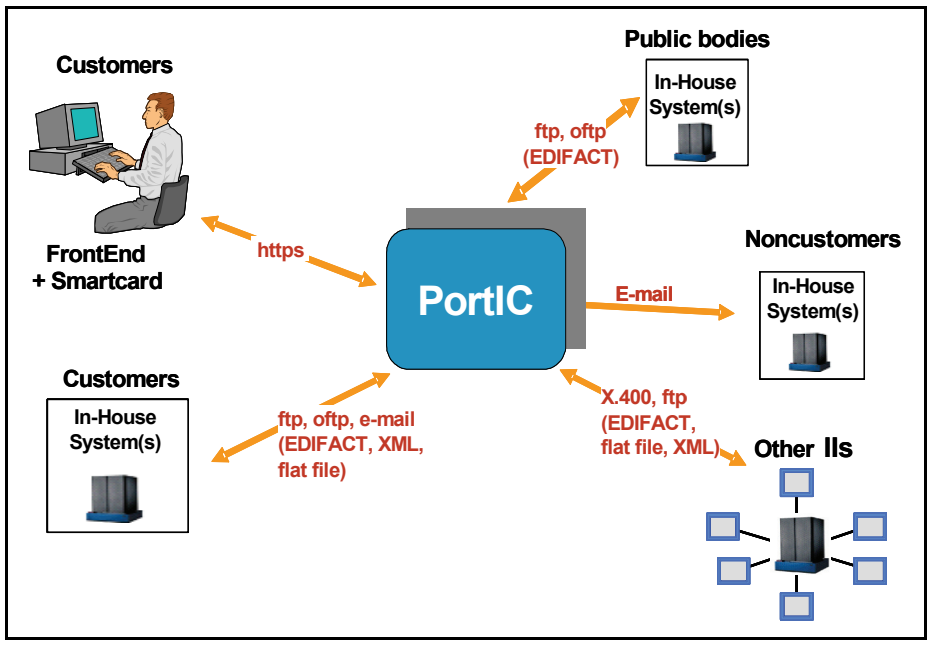

Figure 1. **Technical Actors Enrolled in the PortIC Actor Network**

interests would be realized with the implementation of PortIC. Through the trade associations becoming shareholders of PortICCo, all of the port agents in the port community *enrolled* the network. In that way they avoided any actor outside the community being able to control the *obligatory passage point*, PortIC. PortIC was *portrayed as an obligatory passage point* in the future: a node in the network through which all actors with a stake in the problem would have to pass.

4.3 Stage 3: Development toward Divergence (2000–2001)

By mid-2001, port agents were intensively using the information services and a significant percentage of the messages that the PAB received came through PortIC (private-to-public exchanges). Both networks—the information services and the private-to-public exchanges—became *black-boxes*. In the case of information services, which were used for documentary tracking of goods and statistical purposes, the port agents immediately *enrolled and mobilized* as any of the prior mechanisms required them to spend much more time gathering data. In the case of private-to-public exchanges, port agents *enrolled and mobilized* as they got faster responses from the public bodies when they used the IOIS. In addition, the PAB initially provided port agents with economic incentives to adopt these exchanges; thus, any alternative exchange mechanism would find it difficult to *resist* the new system.

On the other hand, since the PortIC system went live in 2000, the actor network that concerned private-to-private exchanges *developed toward divergence*. Some of the reasons were:

- PortIC's development finished with a 6-month delay, which made potential adopters mistrustful.
- The standard designed at TelFor had been treated as a *frozen actor* with which the processes of port agents were *aligned*. However, once PortIC was in operation, they realized that private-to-private exchanges *inscribed* in the PortIC system did not fit the real working practices. The flows and content of messages *did not adhere* to the daily practices of port agents; thus they did not use PortIC. Trade associations' representatives at TelFor had *failed to speak on behalf of* trade associations' members.
- The security measures that had been *inscribed* into the smartcards were easily *worked around* by users. The choice of smartcards was fairly limited, and was shaped by a number of failures, both technical and social. On the one hand, the smartcards had interoperability problems with FrontEnd, which penalized the latter's performance. On the other hand, the real patterns of use *worked against* the security policy. For instance, most of the users shared their smartcards, their user names, and their passwords with others in their companies. Thus the intended privacy and data security was not achieved. Users finally abandoned the use of the smartcards and the FrontEnd application, and moved back to the use of fax or other systems they already had in place.
- The performance and availability of PortIC was poor due to the system's inadequate capacity. Therefore, the *previous link* between port agents and their existing paper exchange mechanisms (fax), which PortIC *was supposed to weaken*, was actually strengthened as firms abandoned the use of PortIC to the detriment of prior exchange mechanisms.
- Moreover, at the beginning of 2000, one of the IS consultancies abandoned the project. The other consultancy took over responsibility for development of the entire system.

PortIC and the standard defined at TelFor had *failed as devices that cut the links* between port agents and prior exchange systems and procedures (installed base). The *inertia of the installed base worked against the stabilization of the PortIC actor network.*

In addition, a series of events occurred throughout 2000 and the beginning of 2001 that generated more *divergence*.

- PortICCo extended the scope of its services by linking inland transport network operations with those of the Barcelona airport. This idea of integration with other modes of transport was expected to enhance the service to existing customers (e.g., freight forwarders) by *weakening their links* with the systems they were using by that time (fax, Traxon, e-mail). However, once the integration was completed, it did not replace existing systems for airport operations. Freight forwarders were used to prior systems, which in addition had faster response times. On the other hand, some shipping agents felt upset as they considered PortICCo was giving value to freight forwarders beyond the boundaries of the port.
- PortICCo also implemented electronic payment services. However, these services proved unsatisfactory as PortIC did not support bank bills, the most widely used payment mechanism among port agents. None of these services were satisfactorily adopted and were thus discontinued.

- The CEO of PortICCo and the manager of international relations for the PAB commissioned a consultancy firm to design a strategic plan with the aim of transforming PortIC into a global IOIS, which would give service to complementary industries. This strategic plan was presented to new investors, two Spanish banks, who gave support to the initiative and became part of the shareholding of PortICCo. However, former shareholders (trade associations) considered banks' *interests* in doing business were *not aligned* with theirs, and perceived that banks could easily obtain control of the PortIC system—the *obligatory passage point*—in the future. Former shareholders also thought this initiative clashed with the initial idea of PortIC: to be a community project, not a project that went beyond the boundaries of the port community.

4.4 Stage 4: Sorting Out the Divergence (2001)

By mid-2001, the rate of PortIC usage for private-to-private exchanges was far from satisfactory. The PortIC system failed to live up to port agents' expectations. PortICCo's shareholders were dissatisfied with PortICCo management. They felt they had been deceived because PortICCo did not provide the promised service to the community. Various controversies sprang up concerning the development and use of PortIC. Consequently, the *translation process* backtracked to the *interessement stage*. The port agents did not visualize a port without an IOIS but disagreed with the way the IOIS should be implemented and the role of some of the actors (the managers of the IOIS). As the manager of an inland terminal noted, "If PortIC did not exist, we would have to invent it." Then PortICCo's shareholders and TelFor's participants made some changes.

4.2.2 Changes to PortIC

The board of directors of PortICCo replaced the CEO at the end of 2001. He had not been able to *tie up the various interests* in the new system and had failed to establish himself as a *spokesperson*.

The manager of international relations of the PAB was appointed as the new chief executive, and a new general manager and a marketing manager were hired. The new managers, who were under pressure to deliver rapid results, acted to sort out the situation.

- They decided to back-source the development of PortIC. From then on, PortICCo would be in charge not only of the operation of PortIC, but also of its development. The aim of this back-sourcing process (which was completed in 2003) was to provide *technical stabilization*.
- Although they did not abandon the project to transform PortIC into a global IOIS started by the former managers, they focused their attention on giving service to the firms in the community.
- They created the role of the consultant; someone who would be involved in understanding customers' demands and training needs and would also be fully involved in the TelFor activities. PortICCo and TelFor agreed that there was no need to use the smartcards to ensure security, thus this artefact was excluded. This measure

assured the *technical stabilization* of FrontEnd, and in turn the *social stabilization* as users accepted using FrontEnd.

4.4.2 Changes to TelFor

TelFor's participants considered that the standard had to *reflect the interests* of port agents if it was to be fully adopted. TelFor's governance and working procedures were changed. Until then, TelFor had been working with one main group with less than 20 people, who were involved in all of the standardization activities. The scope was too broad, which meant that members were not capable of deciding all of the issues that arose during standardization. Moreover, these people had jobs in their own companies, thus participating at TelFor represented extra hours. Therefore, they decided to change the organization of the standardization work: they set up a steering committee and 17 working groups, each of which would be responsible for a different part of the standardization process. Aiming to close the gap between the practices *inscribed* in the standard and the daily working practices, they put more emphasis on participation. They considered participation would enhance the further use of the IOIS. All the port agents, regardless of their size, were invited to participate in the process.

On the other hand, some private participants at TelFor promoted the creation of a Spanish committee with the goal of standardizing the private-to-public exchanges for most of the ports in Spain. This *new actor*, the Process Harmonization Group, was seen by big port agents as an opportunity to reduce their operating costs at the country level. On the other hand, the PAB and Customs perceived the *new actor as an opportunity* to provide better service to their customers (the port agents) and also to become leaders and promoters of a national standardization initiative. Finally, for TelFor, the Process Harmonization Group was an *opportunity* to extend the scope of its influence and to gain legitimacy.

4.5 Stage 5: Stabilization of the IOIS (2002–2005)

Between 2002 and 2005, the number of participants at TelFor rose from under 20 to over 130. We might attribute this to (1) the sustained leadership and enthusiasm of the chief of the regional Customs office, who was appointed president of TelFor in 2002, and (2) the organizing structure of TelFor, which offered opportunities for users to exert their influence. TelFor had become a dynamic committee in which port agents could make and develop proposals. The progressive involvement of new actors and the new structure helped *align the interests* of participants, and ultimately formed a *stable network* that reflected the working practices of the diverse port agents. *Inscriptions*, although they were paper-based, became *powerful*. All the (human) actors recognized and accepted TelFor's work; its focus was now directed to the outputs and no longer to its internal complexity. The standard transformed into a *black-box* and had a good deal of staying power.

On the other hand, to enhance the use of PortIC for private-to-private exchanges, both PortICCo and the PAB adopted new strategies to *stabilize* the actor network.

First, once the standard was *black-boxed*, the new PortICCo management selected small groups (constellations) of firms. More precisely, in September 2003, they launched

the first partial import scenario with a constellation made of five port agents (a shipping agent, a freight forwarder, two haulers, and an inland terminal). They *aligned the interests* of the port agents in the constellation and those of the PortIC system. PortICCo introduced some changes to the system based on these firms' installed base (systems, uses of the system, message content, etc.). Once these constellations became *stable*, new actors—partners of these firms—*enrolled*. Therefore, the actions that PortICCo carried out aiming to *align* the different interests bootstrapped a self-reinforcing installed base of *actors*. As firms usually participate in more than one constellation, this *alignment process* has to occur more than once. However, successive alignments became easier as actors learned from experience.

Secondly, the PAB imposed a rule in May 2005 for some of the users of the port (holders of inland terminals, depots, shipping agents, and haulers). The reason for doing so was to increase the use of PortIC for private-to-private exchanges. This rule forced these companies to follow the standard defined at TelFor and use electronic means to submit the messages (PortIC was the only IOIS in the port) starting July 31, 2005. According to this rule, inland terminals had to refuse incoming or outgoing containers whose documentary process had not been submitted through PortIC. However, all of the *actors* complained. The inland terminals complained that this rule forced them to decide which hauler (customer) could enter and which could not. The freight forwarders argued this rule did not really penalize shipping agents, but haulers and in turn the shipper, their customer. The haulers claimed they were not ready to send and receive through PortIC. Thus this *inscription turned out to be weak as actors opposed the pattern of use*. The PAB postponed the implementation of the new rule for 2 months. Then the PAB *performed a sequence of trials* (e.g., made an agreement with an inland terminal to become a beta test site for the new rule, launched a training program for haulers) that allowed them to progressively *establish the desired behavior*. This shows that the *inscription* into the haulers' daily practices through training has proved to be *stronger* than through the rule.

As a result of PortICCo and the PAB strategies, the actor network seems to have gradually stabilized.

5 DISCUSSION AND CONCLUSION

Having described and analyzed the implementation of an industry IOIS in the port of Barcelona, we discuss several characteristics of the process.

As the case analysis shows, the implementation of the IOIS can be viewed as chains of translations that run sequentially or in parallel (Figure 2). Each translation process is triggered by a problem or an opportunity. For instance, in stage 1 we see two translation processes: the first one was triggered by the port agents' complaints about the service (e.g., response time) of Customs; the second was triggered by the low rate of adoption of the private-to-public exchanges standard due to the port agents' lack of IT capabilities. In response to an opportunity, the focal actor proposed a solution—create a standardization committee—to develop a common IOIS for the port.

On the other hand, we observe that a translation process may succeed or halt at any stage. When a translation succeeds—the case of the standard in stage 4—it becomes irreversible, that is, it is very difficult to go back to a point where that translation was

only on among many and the translation may shape other translations—for example, the standard becomes a single aligned actor in the network concerning the implementation of private-to-private exchanges (Callon 1991, pp. 150). If the translation halts, then it may be necessary to backtrack. Prior alliances may weaken, translation may halt because of technical tensions as with the smartcards, or social tensions may create problems, as was the case with the project aimed at transforming PortIC into a global IOIS.

The problematization stage culminates in the definition of a situation, namely an obligatory passage point (OPP), that has to occur for all of the actors to satisfy their interests (Callon 1986). Considering the implementation of PortIC as the main OPP (Figure 3), we see that the different actors have to pass through it to avoid several obstacles or threats and to achieve their objectives. The OPP is directly in the path of the main focal actors, the PAB and PortICCo, who are powerful because of their control of the OPP.

	Problematization	Interessement	Enrollment	Mobilization
Stage 1 (1994-97)	P: Complaints about the service provided by Customs S: Standardization of private-to-public exchanges through IGC	* Private organizations wanted customs to improve. * Customs wanted to modernize their service and operations	* The PAB has power to impose the message flows and content to port agents at IGC * The PAB acting as one-stop ship with Customs	-
	P: Low rate of adoption of private-to-public exchanges because there was a lack of IT capabilities S: * Idea: development of a common technical infrastructure for the whole community * Dissolution of IGC. Creation of TelFor to extend IGC's work to private-to-private exchanges.	* Port agents become interested as the common infrastructure avoid them from investing in new systems for their data exchanges * Port agents were interested in a solution that went beyond the private-to-public exchanges * New actors (importers/exporters, haulage contractors, etc) are identified to play a role at TelFor	* The PAB giving economical incentives to those using PortIC for private-to-public exchanges * The threat that represented that other organizations could enter the port and control the information * TelFor would use a consensus approach	-
Stage 2 (1998-99)	P: A community vision: paperless port and improvement in the efficiency of organizations. S: Idea of PortIC (the OPP)	* The Master Plan is approved * Other port already had an IOIS	* The 6-month deadline was a tactic for enrollment into the actor-network * Use of Internet-based technologies to easy the access to PortIC (FrontEnd) * Inscribing a security policy in FrontEnd and in rules	-
	P: There is need to manage the PortIC system S: Define a management model for PortIC	All the private stakeholders in the port community should be involved (trade associations, chamber of commerce).	* Create a company (PortICCo) * The trade associations are offered the opportunity to become shareholders. No external actors, except the Chamber of Commerce, becomes shareholder.	* Standard for private-to-public exchanges stabilizes
Stage 3 (2000-01)	P:* Port agents rejected the use of FrontEnd due to performance of smartcards (users worked around the security measures inscribed in FrontEnd) * Performance problem of PortIC S: Introduce small operative and strategic changes	* Remove smartcards from FrontEnd * Extension of PortIC to new actors (e.g. banks, airline services). This interessement failed	* The private-to-private exchanges inscribed in paper did not reflect real practices. The inscription became reversible (gap between standard for private-to-private exchanges and daily processes)	* Information services stabilize * Private-to-public exchange stabilize
Stage 4 (2001)	P: PortIC usage is less than satisfactory. Port agents start mistrusting the whole project, and are deceived with PortICCo management S: Introduce changes to PortICCo and TelFor	* General interests in the success of a community project such as PortIC * Port Agents interested in controling the project. Negotiations between focal actors and port agents	* Threat that new actors such as banks could control PortIC and consequently their business * The PAB coordinating the work of TelFor and financially supporting it * Creation of a new working structure at TelFor that fostered a wide participation, and that extend their work to a broader context	* Telfor organization and standard stabilize
Stage 5 (2002-05)	P: Lack of use of PortIC for private-to-private exchanges S: Strategies adopted by PortICCo and the PAB	* General interests in the success of a community project such as PortIC * Other seaports had similar initiatives running	* Aligning of constellations interests * The PAB defined a rule * Training programs for haulers * Beta-tester to show the good working of PortIC	* Private-to-private exchanges through portIC started stabilizing

P: problem/opportunity
S: solution to the problem/opportunity

Figure 2. **Translation Processes Throughout the Implementation Stages**

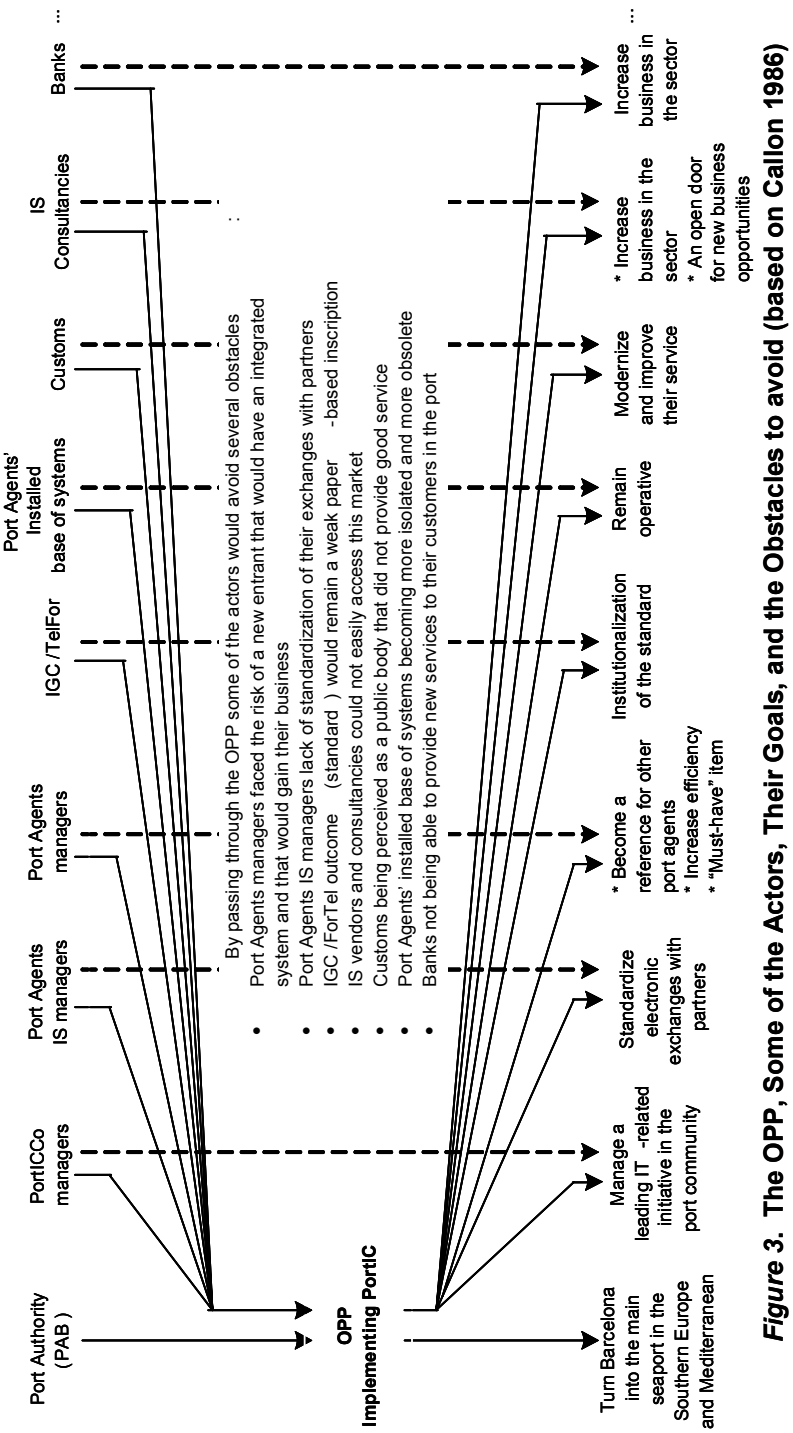

Figure 3. **The OPP, Some of the Actors, Their Goals, and the Obstacles to avoid (based on Callon 1986)**

On the other hand, the other actors may face more difficulties in passing through the OPP. These difficulties rely on the diversity of interests or objectives. For instance, managers of port agents had different perceptions of PortIC: some saw it as an opportunity to become a reference for the other members of the port, others viewed it as an opportunity to increase their efficiency, and still others viewed it as a "must-have" item (an imposition from their clients). For information systems departments of port agents, it meant an opportunity to standardize their electronic exchanges with partners. For existing installed bases—such as EDI systems—PortIC was a threat since it would replace them. However, if they were able to keep their autonomy and integrate with the PortIC, the OPP would be an opportunity for them. For Customs, PortIC would push them to modernize and improve their service. For the standard defined by IGC and later by TelFor, it was an opportunity to acquire additional permanence and to institutionalize. For banks, PortIC meant new business opportunities as fund transfers would be conducted through PortIC. For IS consultancies, PortIC meant a project in an unexploited sector that would open the door for new business opportunities.

As the actor network grows, the risk of conflict increases because of divergent interests. The case demonstrates that changes in the boundaries of an actor network have to be negotiated. For instance, the events in stage 3 show that PortICCo management considered that the PortIC actor network was stable enough to extend it with new actors (e.g., banks). The new actors, however, weakened the stability of the network. That is, the network had been prematurely black-boxed. Trade associations, which were shareholders of PortICCo, offered resistance because the new actors threatened their position in the network. Then in stage 4, trade associations renegotiated their interests with the focal actors in order not to lose power to the banks. Although banks became new actors, they finally played a different role than the one they and focal actors had intended. Banks would not control future decisions about the development of the IOIS, they would not control the OPP.

Some of the actors' interests cannot be foreseen. For instance, if we unpack the actor that constitutes the installed base of port agents, we find hardware, software, processes, developers, organizational structures, etc. In the case of multinational port agents, whose headquarters were outside the port of Barcelona, their installed bases did not easily go through the OPP, because any decision to change to their installed bases had to be taken in headquarters. In addition, port agents' installed bases had not developed equally: some firms had already invested in electronic exchange systems, thus they did not have any interests in using the new system. As the focal actors (the PAB and PortICCo) initially treated the installed bases as black-boxes, they failed to recognize the existence of some actors (e.g., multinationals) with the potential to influence the translation process. The events in stages 2 and 3 demonstrate that installed bases were unstable allies. In stages 4 and 5, the focal actors, aiming to mobilize these installed bases, decided that PortIC would adapt the artefact, the processes, and the design principles in order to accommodate the heterogeneity of installed bases for private-to-private exchanges. They adopted a set of actions that allowed them to build the IOIS on the parts that were functioning well. After that, the IOIS seemed to gain momentum, overcoming the installed base of technical systems, procedures and practices. This shows that black-boxing is reversible (Latour 1987) because the associations made among different actors are often unstable.

Finally, the case also shows that IT played a major role in the image-making strategy. That is, IT mediated the discourse of the promoters (Latour 1987). The focal actors, the trade associations, press articles, and consulting firms portrayed the PortIC systems as the inevitable direction to enhance the competitiveness of the port and create a paperless port, which meant more efficiency in terms of time, cost, and infrastructure optimization. This techno-economic view was attractive not only because of the consequences, but also because of the easy explanations for a successful story. The PortIC system was presented as being technically advanced. In addition, well-established IS consultancies would be in charge of the implementation. Thus, IT was a rhetorical instrument in the persuasion campaign carried by focal actors. However, this strategy finally failed in stage 3 when the project was close to collapse. Focal actors had not fully taken into account the role of other actors—the port agents' systems, interests, internal processes, skills, working habits, etc.—in shaping the implementation process. The focal actors' assumption had been that the implementation process would be mainly shaped and controlled by focal actors' designers, and port agents would adopt it.

This paper contributes both to IOIS research and management. First, this empirical paper adds to existing IOIS literature as it examines both development and diffusion, and studies an industry phenomenon. ANT's focus on how socio-technical actors are brought together in stable networks of aligned interests provides a holistic view of IOIS implementation. ANT has allowed us to trace the course of the implementation by focusing on the translation processes and to identify sources of disagreement between actors' interests, and between the actors and the medium in which the translation was inscribed. Second, this paper adds external empirical validity to the argument by Lyytinen and Damsgaard (2001) and McMaster et al. (1997) that IOIS implementation cannot only be explained by a fixed set of independent factors. Rather, complex dynamics and processes involving different actors (people, technologies, standards, and rules) may complement factor-based models in explaining the evolution and the outcome—success or failure—of IOIS. Third, we present a longitudinal case that provides additional empirical findings to the IOIS literature, and in particular to the small number of studies on IOIS in seaports. We explain how the different actors perform to keep the different interests aligned, and how they struggle to inscribe their interests into textual descriptions, training programs, rules, hardware, and software. Finally, although we cannot assure the generalizability of the case findings, we believe the implementation dynamics presented in the paper are not exclusively from this sector; thus the paper furnishes insights for researchers and managers involved in IOIS implementations.

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Appendix 3

Rodon, J., Ramis-Pujol, J. and Christiaanse, E (2007). "A Process-Stakeholder Analysis of B2B Industry Standardisation", *Journal of Enterprise Information Management*, 20 (1): 83-95

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A process-stakeholder analysis of B2B industry standardisation

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Abstract

Purpose – Interoperability standards are a crucial aspect in the development of B2B e-business. The aim of this paper is to understand how standardisation evolves by analysing the interplay between activities and stakeholders within the process. Unlike most of the IS research that focuses on the underlying technologies within standards, this study explores the standardisation processes and the interaction between the different participants.

Design/methodology/approach – This issue was explored with a case study of the standardisation activity in the Port Community of Barcelona. The primary source of data was semi-structured interviews with members of the standardisation committee, direct observation in meetings and related documentation. Data coding and analysis, using qualitative methods, proceeded in parallel with data collection.

Findings – The analysis reveals critical success factors in the urgency perceived by the dominant stakeholder and the inclusion of a workgroup manager. Also the workgroup manager can have a significant positive impact by focusing on sense-making activities during the first steps of the process.

Research limitations/implications – The study is based on a single organisation and a largely retrospective analysis of two standardisation exercises.

Originality/value – This paper contributes significantly to the literature on vertical B2B standardisation by combining process theories and stakeholder analysis approaches. It demonstrates greater insight into managing successful standards initiatives by taking this holistic approach to the research.

Keywords Electronic commerce, Standardization, Stakeholder analysis, Process management, Case studies

Paper type Research paper

Introduction

The research presented in this paper is based on a case study of the evolution of a standardisation process that has taken place since 1993 in the Port Community of Barcelona. The object of analysis is the work done by a consortium in which members of the Port Community collaborate to standardise the processes and messages exchanged among the port agents.

This paper focuses on the standards that enable organisations to exchange information (i.e. EDI standards). EDI standards have been widely used in the creation

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of electronic trading infrastructures in several industries (Christiaanse and Damsgaard, 2000; Damsgaard and Lyytinen, 2001). Ocean port communities have historically applied EDI for trading and as the basis for the standardisation of the data and processes that are part of the messages exchanged among companies (van Baalen *et al.*, 2000; Wriley *et al.*, 1994).

Within the literature of standardisation in the IS domain, there are studies that use a *process* model for the analysis of the activities performed in the standardisation (Fomin *et al.*, 2003). Others focus on the identification and definition of the role played by *stakeholders* (de Vries *et al.*, 2003). The link between process and stakeholder models has not been studied in detail. This paper contributes to the literature on the development of B2B industry standards with an exploratory research study that looks at the standardisation phenomena from two perspectives: on one hand it analyses the process steps, and on the other hand it examines the stakeholders that participate in the process.

The structure of the paper is as follows: a literature review on standardisation is presented in the next section. The third section presents the research framework. Next, the fourth section introduces the methodological issues relevant for this research. The fifth section presents the case of standardisation at the Port Community of Barcelona, while the sixth section discusses the findings that emerge from the case study. Finally, the paper provides conclusions and some suggestions for future research.

Literature review

This paper deals with standards that emerge through cooperation and joint effort of members of one or more industries that form a consortium (de Vries, 1999). Regarding the outcome of a consortium we distinguish between horizontal standards (e.g. EDIFACT, ebXML) and vertical standards (e.g. CIDX, papiNet). The latter ones address the business problems to particular industries and are concerned more on the use of IT and on the semantics of information and business processes, than on IT (Wigand *et al.*, 2005).

Social theories describe standardisation as "heterogeneous engineering", meaning that it deals with both technical and social aspects (Graham *et al.*, 1995). Standards are in constant flux as they are used in practice, so the standardisation should be reckoned as a continuous, real-time process (Damsgaard and Truex, 2000). Similarly Hanseth *et al.* (1997) consider that standards are negotiated, developed and shaped through complex social processes. Accordingly, social theories are suitable to explain why the standardisation process follows one or other course (Fomin and Keil, 2000).

Within this social approach, there is a line of research that conceptualises standardisation as a formal multi-stage process (Jakobs, 2002) which can be modelled *ex ante*. Another views standardisation as an informal process which results from the interaction of design, sense-making and negotiation activities (Fomin *et al.*, 2003). Within this process approach, the change management literature could also be useful in explaining standardisation. According to Pettigrew (1985), change should be seen as a process that is simultaneously analysis, politics and learning. Schwenk (1989) indicates that different political groups in a firm use different mental models to interpret different events and their corresponding solutions, which coincide with the interests of the group. These perspectives are close to the idea that organizational

contexts are basically enacted (Weick, 1979) but give a slight preponderance to the political dimension. Tichy (1983) presents also a multidimensional model based on the imbrications of three dimensions:

(1) political;

(2) technical; and

(3) cultural.

According to the author, these dimensions are loosely coupled (Orton and Weick, 1990), and therefore the initiation of a change process may need their "decoupling".

Another line of research on standardisation, which is close to the political dimension, has emphasised the stakeholders involved in the process. Jakobs *et al.* (2001), who looked at the motivations, attitudes, and views of people at standardisation committees, suggest that cooperation is a key element for satisfactory standardisation outcome. Jakobs *et al.* (1998) state that user participation is desirable and requires mechanisms aligning heterogeneous user requirements during the process. de Vries *et al.* (2003) present a method for systematic identification and classification of stakeholders. They use Mitchell *et al.*'s (1997) typology of stakeholders, which is based on the determinants of stakeholder salience, to classify the stakeholders in the standardisation process.

Although standards result from a process of social interactions between stakeholders, the link between process or stage and stakeholder models has not been studied in detail. This paper contributes to filling this gap.

Research framework

In order to analyse and explain the standardisation process we use the research framework in Figure 1. This framework has three main constructs: First, we consider the *tasks* performed during the standardisation process. Second, we consider the stakeholders by looking at the *stakes* in the standardisation process. Adopting Freeman's (1984) definition, in a standardisation process a stakeholder will be any group or individual who can affect and may be affected by the outcome of the standardisation. For the determination of stakes we use the stakeholders' salience –"degree to which managers give priority to stakeholder claims" (Mitchell *et al.*, 1997, p. 854), and rely on three variables: power, legitimacy and urgency (Mitchell *et al.*, 1997). Finally, there are the *roles* that participants in the standardisation process may adopt. These roles are defined *ex ante* and have some associated responsibilities.

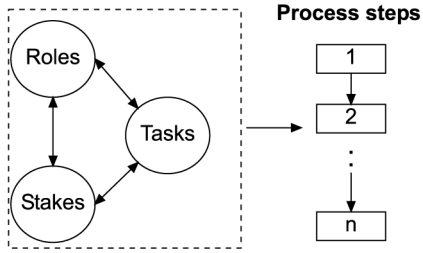

Figure 1.
Research framework

This paper thus addresses the following research questions:

- How do stakeholders perform the different activities along the standardisation process?
- Can any patterns among these constructs (tasks, roles and stakes) explain the outcome of the standardisation process?

Methodology and data collection

To perform an in-depth study of this social-technical phenomenon we choose the case study methodology, which is useful in helping to understand how and why processes occur (Yin, 2003). The data that we have collected is mainly unstructured and qualitative. The primary sources of data have been semi-structured interviews with members of the standardisation committee, meeting minutes, direct observation in meetings, output documents from the standardisation, and secondary sources as press articles. Over two periods (January-March 2004 and February 2005) we conducted 15 interviews, each lasting on average one hour. Interviews were tape-recorded, transcribed, coded and analysed. Data collection focused on the types of activities and stakeholders, the critical events and the role of stakeholders. Data collection, coding and analysis proceeded iteratively (Glaser and Straus, 1967).

Case study

Context of the case

A large number of organisations – the Port Authority of Barcelona, shipping agents, stevedores, the Harbour Master, forwarding agents, Customs, pilots, haulers, customs agents, ship owners and shipping companies, etc. – form a complex network at the Port of Barcelona. Within this network, organisations interact with the aim of carrying out the *physical* tasks involved in moving the goods and the *administrative* tasks related to the execution of the service order by the client. Each organisation in the network generates some kind of information that will be provided to others who, on the basis of this information, will carry out their corresponding operations. The standardisation and automation of these inter-firm data exchanges are both crucial for the efficiency of the whole network.

Standardisation in the Port Community of Barcelona has been ongoing since in 1993. It aims to standardise all the processes and documents exchanged among the port agents. For that purpose, a consortium was created called Telematic Forum (TF) to lead this project. TF's governance consists of a steering committee that coordinates the entire project and a set of workgroups that are in charge of different parts of the standardisation project.

Stakeholders in the standardisation process

Before starting data collection and based on Freeman's (1984) definition of a stakeholder, we asked some members of the consortium to identify the stakeholders (Figure 2). First we see three main groups of organisations:

(1) public bodies;

(2) private participants; and

(3) other standard development organisations and consortia.

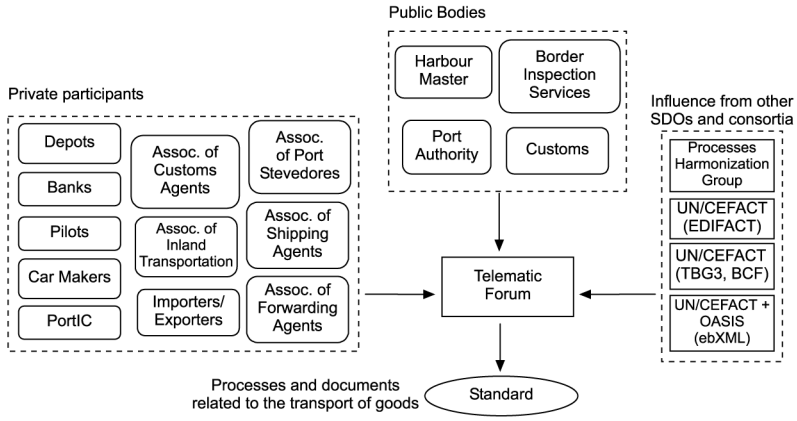

Figure 2.
Map of stakeholders involved in the standardisation process

Likewise, we may distinguish between those organisations that participate in the steering committee, in a workgroup, or in both places.

Process of standard creation

The whole standardisation process is organized as a set of small standard setting projects, which all move through the same stages (Appendix 1). A project starts when a proposal sent by any of the stakeholders is approved by the steering committee. Then, the steering committee creates a workgroup, chooses the type of stakeholders that should be involved in the workgroup and selects the stakeholder that might manage it, usually the one that has most at stake. Next, the steering committee asks the associations to select their representatives in the workgroup. After, the workgroup will engage in a set of activities to work out the initial proposal. The participants in this workgroup represent their respective associations:

> I bring the Association's vision into the process [. . .] and I'm in charge of transmitting and asking the associates about any subject that may matter them (Workgroup member).

Standard development in two workgroups

Stage 4 of the standard creation process (Appendix 1) is where the difficulties of standardisation present themselves. The output of this stage is three documents:

(1) a prototype;

(2) a user guide; and

(3) a documented process.

To further illustrate this stage we use two cases corresponding to two workgroups created in May 2001.

The first workgroup (WG1) aimed to define a standard scenario for electronic invoicing at the Port Community. WG1 consisted of nine participants belonging to seven different stakeholders (Appendix 2). By December 2001, WG1 had reached stage 6 and the steering committee decided to temporarily close it while waiting for a European directive that enabled electronic invoicing with a digital signature.

Meanwhile, the technology provider kept on working with the technical tasks that did not depend at all on this directive, such as the definition of the XML message and analysis of the implementation alternatives. In February 2003 the steering committee reopened WG1 with the aim of studying the new European directive and adapting it to the existing procedure and electronic message.

The second workgroup (WG2) aimed to standardise the processes and data associated with the entrance and exit of goods into and out of the port by railway. WG2 consisted of 15 members belonging to eight types of stakeholder (Appendix 2). The initial WG2 manager was substituted in 2003.

Analysis

We notice some key differences between the dynamics of both workgroups. To analyse both cases and present these differences we use the research framework presented in Figure 1.

Process steps. For both cases we cluster the activities and identify the process steps in Figure 3. By February 2004, WG1 had gone through all the steps. By December 2004, WG2 was stuck in working simultaneously on process steps 4.1, 4.2 and 4.3 and had not gone further.

Roles. Each workgroup had three specific roles:

(1) the manager;

(2) the activity manager; and

(3) the members.

The managers in WG1 and WG2 were the technology provider and the railways company, respectively. Each role in the workgroup was expected to perform some activities. The manager was supposed to:

- motivate active participation;
- make proposals within the workgroup;
- align member interests;
- assign activities to workgroup members;
- coordinate and monitor members' work;
- arrange workgroup meetings;
- collect results;
- channel the information among the workgroup members;
- document the output of meetings; and
- present workgroup results.

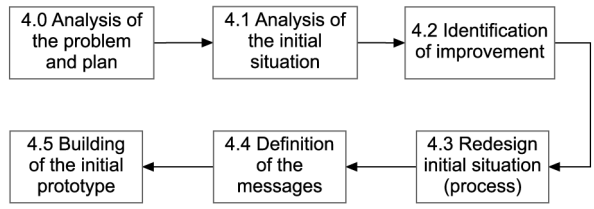

Figure 3.
Process steps of the standard development stage

The activity managers were supposed to work on specific workgroup activities and present the results to the workgroup. The members were supposed to contribute with their knowledge to legitimise the output. Finally, there was the role of the consultant who was supposed to coordinate all the workgroups and present the results to the steering committee. Table I presents the tasks executed by each role.

Tasks. Initially, the manager of WG1 worked on motivating and showing the benefits of the project to all the stakeholders. Then, analytical tasks were distributed among the members; they worked on them outside meetings, and presented the results to the rest during meetings:

> [T]he first thing I did was a study of the invoicing costs in my company [. . .] Since then, we had a basis to start working (Workgroup member).

The manager of WG1 distributed the work among the members, monitored them, arranged and coordinated the meetings, defined the scenarios, and arranged presentations of similar initiatives to give some light to the members:

> [The workgroup manager] linked and packed our ideas, and fit them to accomplish with the existing law (Workgroup member).

The definition of the process took place during meetings and involved all the members:

> [R]egarding the process definition we start with the data that all members brought in [. . .] During the meeting we design the processes [. . .] Everybody could follow it and agree on the final process (Workgroup manager).

On the other hand, WG2 members, except the consultant, Customs and PAB participants, only made contributions during meetings and rarely prepared them in advance. The consultant performed most of the workgroup management and the manager was not able to attend some meetings during the first two years. In 2002 the steering committee asked the railways company to elect another representative to replace that manager. In a 2004 meeting one of the WG2 members complained about the status of the project:

> We saw similar diagrams last year with the former manager [. . .] but this has changed a lot [. . .] Is it possible to represent this diagram given the complexity and changing of the environment? (Workgroup member).

The members of WG2 have also changed since its creation, which makes the work assignment, the sharing of common values and rituals of the workgroup, and the identification with the goals of the workgroup very difficult:

> [E]very meeting there are new members coming [. . .] We start discussing the same issues [. . .] and we do not move forward (Workgroup member).

Role	WG1	WG2
Manager	Performed as expected	Played the role of a member
Consultant	Performed as expected	Played both the roles of manager and consultant
Activity managers	Performed as expected	There were no specific activity managers
Members	Performed as expected	Performed as expected

Table I.
Workgroup tasks

In WG2, members complained about the heterogeneity of working practices in each company. This fact made very difficult for them to represent and act in the name of their association.

Stakes. In WG1 power was distributed among participants. However, due to the nature of the project, the technology provider was the manager and had most power. Legitimacy was distributed among the participants depending on the type of task being performed. At technical tasks (steps 4.5 and 4.6) the technological provider had the legitimacy, while at more functional tasks (4.2 and 4.3) the port agents had more legitimacy. Most of the participants argued that the project had a clear return although it was not perceived as urgent:

> People come to meetings, stay for two hours, provide information and give their opinion. But there is not a clear identification with the project. For instance, none of the members has come to me and said: it's urgent for me to implement electronic invoicing (Workgroup manager).

However, we interpreted that the technology provider as the one who finally would implement the solution had the highest stakes involved and was the most interested in finishing the project. The technology provider also was the one who submitted the proposal to standardise the electronic invoicing to the steering committee.

In WG2 the PAB and the technology provider submitted the proposal to the steering committee. Then, the steering committee selected the railways company to manage WG2 because it was perceived as essential in the project. In the beginning (i.e. 2001), it was Customs who had power:

> [I]nitially improvements came only from the Customs [. . .] They [the rest of the members] only wanted to improve Customs operations but when it was time to reach an agreement among the private agents everything got stuck [. . .] Furthermore, meanwhile the workgroup manager was moved within her company (Workgroup member).

After this, the railways company had the power because it was at the centre of most of the processes involved in this project.

Regarding urgency, the technology provider has shown considerable interest in developing a software application. Likewise, in WG2 meetings some keys members did not attend, which gave little validity to the conclusions. On the other hand, the manager of WG2 explicitly showed his lack of urgency and interest in the standardisation process. In a workgroup meeting in January 2004 he talked about a probable restructuring of the managerial position in his company, and expressed uncertainty about his future position. The railways company seemed to frustrate the standardisation efforts.

> [T]he railways seems to have no interest in this project [. . .] I don't see any exit to the current situation (Workgroup member).

For a detailed representation of stakes in WG1 and WG2, see Appendix 2.

Discussion

First, we identify two main periods in the life of the TF. The first period took eight years (1993 to mid-2001). During this period the output from the TF was about 20 documents and processes that were taking place in the Port Community. However, the adoption rate of the standard was very low. From the data gathered it seems

there was a problem on the requirements elicitation (Loucopoulos and Karakostas, 1995). The potential adopters of the standard complain about the practices and data structure that were embedded in it. They could not identify such practices in their daily operations. So, as a result of the non-satisfactory outcome during the first period the TF changed the governance. In this second period, which has not finished yet, they defined the roles of the workgroup manager and the consultant. Both have become essential in order to speed up and increase the acceptance of the standardisation process.

Second, we see a coincidence in the data that lead us to distinguish two patterns. When a stakeholder who has power and legitimacy but might not perceive urgency (Mitchell's "dominant stakeholder") is the manager but does not act as such, it seems that the standardisation process gets stuck in the analytical process steps and never comes to a closure. When a stakeholder who has power, legitimacy and urgency (Mitchell's "definite stakeholder") is the manager and acts as such, it seems that the probability to go through all the necessary process steps increases significantly. Accordingly it seems that the consultant is necessary, but not crucial. There seems to be a need for that managerial role to facilitate the process.

Third, in our study we perceived an increase in the interest for standard adoption among those who have participated in the standardisation. This matches the literature, which suggests that better stakeholder involvement increases standard acceptance and adoption (de Vries *et al.*, 2003) and that participants are more willing to adopt the new system (Premkumar *et al.*, 1997; Wriley *et al.*, 1994). However, this issue needs further research in the future.

Finally, this research confirms the dynamism of the stakes during the standardisation (de Vries *et al.*, 2003) and highlights that the stakeholders that participate in the standardisation have a range of stakes that vary among their nature and drive their attitude towards the process. Most of the commitment, support and proposals to the TF come from public bodies and the technological provider while private operators tend to be more reactive (Appendix 2). Public bodies and the technology provider also look at the standardisation as a possibility to improve their services.

We have also found that in workgroups whose main focus is the standardisation of relations among private port operators (buyer-supplier relations in particular) the process becomes complex and tasks take much longer. In such relations participants do not accept extra work without compensation, or perceive the fact that others start doing what they were doing as an invasion of responsibility. In such cases the urgency and commitment of stakeholders is very low and the workgroup manager has difficulties aligning stakeholders' interests. A continuous identification of participants' stakes appears to be very important (Christiaanse and Damsgaard, 2000).

Conclusions and suggestions for further research

In this paper we have analysed the interplay between tasks, stakes and roles in a standardisation process. We present the following conclusions:

- First, we observe design, sense-making, and negotiation cycles (Fomin *et al.*, 2003) within the list of tasks performed within a workgroup. From our data it seems that if a workgroup manager focuses more on sense-making activities

during the first steps of the process then the workgroup will go through all the process steps. On the other hand, when sense-making is not done properly at the beginning of the standardisation the workgroup might get stuck with reiterations and potentially does not get to the more analytical and design oriented steps of the process.

- Second, it seems that when the dominating stakeholders in the workgroup are not motivated by urgency, the standardisation outcome is not guaranteed. We saw in WG1 where urgency was stressed by the technology provider that this had a positive effect on the activities, and sense-making, negotiation and design were influenced by the stakes of the dominant role in the standardisation process. As Mitchell *et al.* (1997) suggested, urgency next to legitimacy and power, is an important explanatory construct.
- Finally, taking into account both process and stakeholder perspectives provides a better explanation of standardisation outcomes than a disjoint analysis of process or stakeholder approaches. This follows the multidimensional perspective presented by Pettigrew (1985) and Tichy (1983). The identification of roles and stakes, in addition to concrete activities conducted in the standardisation seems to point at some clear patterns that require more research.

Although the use of a qualitative case study grounded in empirical data has been useful to explore the standardisation process in the Port Community, we think future research needs to examine other contexts as well. Some other limitations of this study are:

- we have used two cases corresponding to two of the 17 possible standard setting projects;
- we have only conducted 15 interviews;
- it is a retrospective analysis so outcome might have influenced the perceptions of standardisation participants; and
- more data from the period 1998 to mid-2001 could also significantly improve our context understanding.

We argue that future research on B2B standardisation initiatives should focus on understanding the process and outcomes by adopting a holistic approach that examines the stakeholders involved as well as the activities they perform. We hope that the preliminary exploration of this case study will provide other researchers with anchors to conduct further empirical studies on this increasingly relevant subject.

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Appendix 1

Stage	Description
0. Proposal making	The steering committee receives a proposal and redirects it to the rest of the Port Community
1. Proposal analysis	Each organization of the Port Community receives the proposal before the meeting, which is announced in the media at the Port Community and the website
2. Proposal approval	During the meeting they debate the usefulness and appropriateness of the proposal, make corrections if necessary, and finally approve or reject it. Decisions are made by consensus
3. Workgroup creation	If the proposal is approved, a new workgroup is created to determine which associations may participate, and which association should manage the workgroup. After that, the associations involved in the workgroup will select the member/s who will participate in the workgroup
4. Standard development	The workgroup receives a problem to solve. The group manager arranges an initial meeting with the rest of the workgroup members, where they define the activities, choose a manager for each one, and fix some deadlines. The workgroup works on the problem to standardise. During the steering committee's meetings they monitor the workgroup
5. Standard approval	Once the workgroup finishes with the project, its work is presented to the steering committee for final approval, after which the workgroup is closed
6. Standard publication	Once approved, it is published on the TF website to be available to the whole Port Community

Notes: The length of the different standard setting projects, from stage 0 to 6, varies a lot. On the one hand, of the 17 projects that have started since May 2001 seven have now concluded. The shortest took one and a half months, and the longest took 19 months, while the rest took between three and six months. On the other hand, there are three projects that had started by mid-2001 and are still in progress

Table AI.
Standard setting process project stages

Appendix 2

	# repres. in steering comm.	# workgroups participation	# proposals in 2003	WG 1						WG2					
				Participates	Workgroup manager	Proposal	Power	Legitimacy	Urgency	Participates	Workgroup manager	Proposal	Power	Legitimacy	Urgency
Port Authority	3	16	5	x			x	x		x		x		x	x
Ships agents	1	15	0	x				x		x				x	x
Customs agents	2	11	0	x				x		x				x	x
Freight forwarders	2	10	1	x				x							x
Port stevedores	1	6	0	x				x		x				x	x
Customs	3	12	3							x			x	x	x
Railways	1	2	0							x	x		x	x	
Technology provider	1	11	4	x	x	x	x	x	x	x		x			x

Notes: The first column shows the number of representatives of each stakeholder in the steering committee. The second column shows the number of other workgroups where this stakeholder participates. Third column shows the number of proposals made by this stakeholder to the TF during 2003

Figure A1.
Stakes in WG1 and WG2

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Appendix 4

Rodon, J., and Pastor, J. A. (2007), "An Application of Grounded Theory to Study Managerial Action during the Implementation of an Inter-Organizational Information System", 6th European Conference on Research Methodology for Business and Management Studies, Lisbon.

An Application of Grounded Theory to Study Managerial Action during the Implementation of an Inter-Organizational Information System

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Abstract: This paper shows the application of Grounded Theory (GT) method in a research project that studied the role of managers of an inter-organizational information system (IOIS), during and after the implementation of the IOIS. We present the steps being followed –sampling, data collection, analysis, and literature comparison–, paying special attention to the intricacies that arose during the research process, and we reflect on the lessons learned from using GT in an interpretive case study. We favoured the "Straussian" version of GT over the "Glaserian": first, because the former view treatment of the existing literature, and second, because the Straussian version provides us with the coding paradigm analytical technique, which allows us to focus on process data. The paper shows: firstly, how grounded theory analytical techniques are useful to analyze process data; secondly, how action diagrams can help structure and report on process data; and, thirdly, the importance of flexibility, creativity, and being open mind in using the analytical tools of GT because it may take different directions before a plausible theory starts to emerge. The objective of the paper is to give a personal perspective that may help novice researchers in the use of GT.

Keywords: grounded theory, coding paradigm, action diagrams, IS implementation

1. Introduction

Grounded Theory (GT) can be traced to the seminal work of Glaser and Strauss (1967), "The Discovery of Grounded Theory". In this book both authors were critical of what they perceived to be a way of research that drew upon an existing "grand theory" (Mills, 1959), and that was satisfied with testing hypotheses build on this underlying theory. In contrast to this hypothetic-deductive approach, GT starts with observations, which are made not to test existing theories, but to discover and generate theories that are as close as possible to the reality observed.

While there are no major differences between Glaser and Strauss views towards key elements like theoretical sampling and constant comparison, the two founders of GT took somewhat different paths. Strauss proceeded to refine the technique of coding by incorporating more analytical techniques, and attached a more active role to the researcher (Strauss and Corbin, 1990). Glaser, on the other hand, argued that rather than putting more emphasis on methods and forcing structure onto data, the researcher should take a passive stance free from preconceptions, trusting that theory will emerge (Glaser, 1992). In this paper we favour the "Straussian" version over the "Glaserian" one, because the former view treatment of existing literature, as well as because the "Straussian" version provides us with the coding paradigm (Strauss and Corbin, 1990).

This paper illustrates the application of GT to study the implementation of an inter-organizational information system (IOIS) in the seaport of Barcelona (Rodon, et al., 2007a). From the outset this research was motivated by a concern for the difficulties that companies had to face in the integration of their information systems with the IOIS and the further use of the IOIS.

The structure of the paper is as follows. First, we justify the use of GT. Next section presents the research process we have followed: sampling, data collection, data analysis, data presentation, and theoretical sampling. Finally, the paper highlights several points of the research process and presents the conclusions.

2. Reasons for the GT choice

Our early research question was: how does the integration of pre-existing systems with an IOIS unfold? The answer to this research question required us to adopt a process perspective to study the implementation of an IOIS. Then we read some papers that reviewed existing IOIS literature,

and we found very few empirical papers proposing process models. Therefore, given the state of the art in process-based IOIS research and our interest in generating new insights relative to the existing literature, we refused a purely deductive, hypothesis-testing approach. Rather, after an evaluative process, the research methodology we chose was GT. More precisely, we would conduct an in-depth case study that would follow the principles of GT. According to Eisenhardt (1989), using case study data to build GT has three major strengths: 1) it is likely to produce "novel theory" (p. 546), 2) "the emergent theory is likely to be testable" (p. 547), and 3) "the resultant theory is likely to be empirically valid" (p. 547).

Thus the use GT was justified for the following reasons. First, GT allowed us to focus on context-based, processual descriptions of the implementation (Myers, 1997). We were concerned with discovering process in data, more precisely, in patterns of action and interaction between the people in response to the problems and situations in which they find themselves (Strauss and Corbin, 1994). Second, GT consistency with interpretive case studies: "ours is interpretive work and…interpretations must include the perspectives and voices of the people whom we study. Interpretations are sought for understanding the actions of individual or collective actors being studied." (Strauss and Corbin, 1994, p. 274). Finally, GT provided a set of established guidelines both for conducting data collection and analysis (Goulding, 2002), which offer us a sense of security when delving into the unknown territory that becomes IOIS management.

3. The Grounded Theory Building Process

3.1 Entering the field and Conducting a literature review

We entered the field at a very early stage, when we conducted two cases studies in the research setting –the seaport of Barcelona– (Rodon, 2003; Rodon, et al., 2007b). Likewise, we read existing literature on IOIS in seaports. Consequently, we acquired some prior knowledge about the phenomenon and the setting, and delimited our research problem.

Next, as we chose to use GT method, we started analyzing papers in the IS field that had used GT. We then discovered that there were the Glaserian and the Straussian approaches to GT, and moved back to read the seminal work of Glaser and Strauss (1967). We also complemented the authors seminal work with the reading of Goulding (2002), and other papers that contrasted the Glaserian and the Straussian approaches. Finally, we opted for the Straussian version because we found it more straightforward and helpful in guiding our data analysis. We then read carefully Strauss and Corbin (1990; 1998).

In parallel, we conducted an initial literature review on IOIS implementation (Rodon, 2006), which confirmed that that there was a lack of studies that adopted a process approach to study the IOIS implementation, and thus this was an unnoticed area to investigate. Regarding the use of the existing literature Glaser (1992) states that "there is a need not to review any of the literature in the substantive area under study. This dictum is brought about by the desire not to contaminate…it is vital to be reading and studying from the outset of the research, but in unrelated fields" (Glaser, 1992, p. 32). On the other hand, Strauss and Corbin (1990) are more open to the role of existing literature, maintaining that "all kinds of literature can be used before a research study is begun" (Strauss and Corbin, 1990, p.56).

In our case, however, given the results we obtained from the literature review, we were not contaminated by existing theory as it did not bring about any hypothesis. We moved into the next step of the research process without a preconceived theory or model in mind; thus we started with an area of study –IOIS implementation–, a focus on the implementation process, an immersion into the research setting, and allowed the theory to emerge from the data. Figure 1 shows the stages that we have followed in the GT building process.

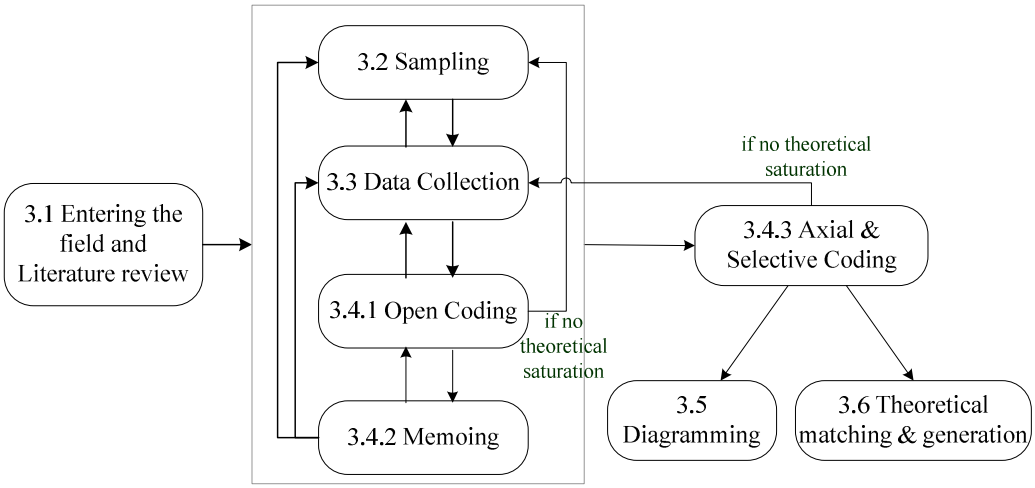

Figure 1: Grounded Theory building process

3.2 Sampling

Sampling is an ongoing part of the process of data collection that consists of selecting a sample according to the emerging theory. On the one hand, the collection of data is guided by the sample; on the other hand, the sample is redefined by the emerging theory; therefore, it is impossible to predict the size of the sample prior to starting the study.

We started with an open sample, which consisted of 11 companies that were operating at the Port of Barcelona. We selected those companies based on the following criteria: 1) companies playing different roles (freight forwarder, hauler, shipping agent, inland terminal, etc); and 2) companies that had been successfully using the IOIS or that had failed to use the IOIS. These companies were selected after we interviewed managers of the IOIS and the Port Authority of Barcelona. Then we wrote and sent letters inviting the companies in the sample to participate in the study. The letter was jointly written by the main researcher and the manager of the IOIS. We stated the aim of the study as: “enhance the understanding of the use of PortIC [the name of the IOIS] in order to define new information services and applications that would increase the efficiency and effectiveness of transactions, as well as enhance the use of PortIC among port agents”. All the companies we requested, accepted to participate in the study.

3.3 Data Collection

We started interviewing the general manager of five of the companies in the sample. We asked these managers to explain their view of the IOIS, the reasons for adopting it, the expected benefits, and the problems they were facing in integrating with and using the IOIS. Once we had interviewed these managers, sampling became more focused. We then turn to interviewing real users of the system (operational managers and clerks) and information systems personnel of these companies (managers, analysts, and developers).

We asked them to explain their experience in using and integrating with the IOIS, paying special attention to relevant events and problems that shaped the way they were using the system and the way their companies were integrating their existing systems with the IOIS. Conceptually our research concerned with understanding human behaviour and action from the informants’ perspective. We prepared some general questions that served as a guidance during the interviews, but that never prescribed the questions we asked.

All the interviewees accepted being recorded. That facilitated our work during the interviews as we could exclusively focus our attention to listening and understanding informants. Interviews were conducted both in Spanish and Catalan. All the interviews were conducted and transcribed by the main author. Each interview was transcribed immediately after it was conducted; never after more than three days. That way, we could add our fields notes regarding our impression about interviewees corporal language, voice tone, attitude, etc. The interviews were transcribed verbatim, without any adaptation to expressions. In case the interviewee had fluency problems, we did not

replace the interviewee's words; rather we added our interpretation. Likewise, when during transcription we found any jargon that we did not understand, we called the interviewees and asked them for the meaning of those terms. Thus we adopted a constructivist approach to GT as we added our perception of how the interview went.

Finally, we conducted 27 interviews over a 9-month period (March 2005-November 2005). In addition, we also collected data from other sources: meeting minutes, internal document, company visits, and attending meetings. These data sources complemented interview data, as well as guided the sampling.

Table 1: Summary of the interviews conducted

Type of firms	Number of firms	Number of interviews	Position
Shipping agent	2	6	CEO, IS manager, Operations manager, user
Freight forwarder	4	6	Maritime manager, IS manager, user
Inland terminal	1	3	CEO, Operations manager, IS manager
Hauler	2	4	CEO, Operations manager, IS manager
Port Authority	1	3	IS manager, Analyst
IOIS	1	5	CEO, Marketing manager, Analyst

3.4 Data Analysis

We followed the principle of continuous interplay between data collection and analysis. During the whole analysis, we used the computer software QSR NVivo 2.0 to organize the vast amount of information collected, and support our codification.

3.4.1 Open Coding

In GT, analysis involves the assignment of concepts and themes to the data gathered. This process, called coding, consists of fracturing, conceptualizing and integrating data to form theory.

The interviews were transcribed verbatim and analysis of the data began with a microscopic (sentence-by-sentence) examination of each interview (Strauss and Corbin, 1990). The microscopic examination was the first step in the open coding process used to create initial codes for comparisons. During open coding, "data are broken down into discrete parts, closely examined, and compared for similarities and differences" (Strauss and Corbin, 1998, p.102). We started codifying without predetermined ideas or a preconceived model. Initially, we used codes based on the terms used by informants (in vivo codes). In the early stages of open coding we obtained 241 codes.

The iterative process of data collection, coding, and analysis gave new insights into the research, helped to formulate new questions in subsequent interviews and guided us on the most appropriate informants. Categories emerged through constant comparison (Glaser and Straus, 1967) of instances of data to see if they fit with each other. The similarities were then grouped into more abstract concepts. Likewise, there was a continuous feedback with informants, which allowed us to look for new informants as well as check that emerging concepts fit the reality.

Once initial categories emerged, the analysis moved into a new stage where the diverse concepts were grouped and organized into trees (see Table 2). In this stage we also started conceptualizing some of the open codes according to prior literature. For instance, in codifying the semantic interoperability conflicts that firms faced when they integrated their systems with the IOIS we used Park and Ram's (2004) classification; or in codifying the extent of use of EDI we used Massetti and Zmud's (1996) facets for EDI usage.

We terminated further collection of data when during the analysis we found that similar incidences and events occurred over and over again, thus further data collection add nothing to what we already know.

Table 2: Concepts that arose during open coding organized into trees

Concepts	Open Codes
Adoption	Adoption reasons (mimesis within the port community, mimesis outside the port community, sense of community, to be an example, follow the clients, have good relation with the port authority); Expected benefits (agility, simplicity, speed, less work, less time, better service, better quality of work, better planning, reliability, improve productivity, no queuing, extend working hours) ; Non-adoption reasons (scope of standard, lack of preparation); Beginning; Sunk costs; Pressure; Critical mass; Readiness; Sense of responsibility
Communication	Personal-Impersonal; Electronic channels; Fax exchange; Communication problems; Multiple channels; Paper exchange; Asynchronous
Company	Structure; Size; Scope of operations; Business; Commitment; Internal process; Customer focus; Dependence on headquarters; Location; Planning process; Relations with trading partners
Consequences	Dependence; More work; Improve service; Impact on business units; Perceived benefits; Partner relation; Return; Effects on non-integration; Side effects; Effects from bad operation; Consequences from channel duplication; Uncoordination; Interdependent benefits; Changes of individuals work; Less data entry; Agility; Logistics; Container control; Spring effect
Implementation	Period; Post-implementation; Implementation problems; Adaptation; Testing; Training; Power
Industry	Sector competitiveness factors; Other port communities; Barriers to competitiveness; Other IOIS; Relevance; Diversity of interests; Industry association
Integration	Semantic interoperability (data representation conflict, schema isomorphism conflict, schematic discrepancy, data unit conflict, entity identifier conflict, generalization conflict); Problems with integration; Next steps with integration; Network integration; Meaning of integration; Internal integration; Interface integration; Evolution of integration; Database changes; Changes in applications; Manual integration; Changes in processes; Syntactic interoperability; Dedication; Particularities; Changes in ICT infrastructure; Automatic Integration; Path dependency; Pragmatics
IOIS	Value of IOIS; Future services of IOIS; IOIS role; IOIS perception; Problems of IOIS; Processing capacity; Strategy; Services; Pricing; Involvement in standardization; Ownership; Business model; Marketing
Message	Message analysis; Check content; Message format; Message generation; Message persistence; Message reception; Message translation; Error messages; Diversity of messages; Acknowledgement of receipt; Acknowledgement of processing; Check flow of messages; Message processing
Process	Responsibility over the process; Check status; Prior process; Physical process
Standardization	Participation; Adoption of the standard; Perception; Discrepancy; External influence; Standard committee; Visibility of information
Technical level	Technological Change; Standardization of infrastructure; Database location; Software application; Connector; System in-place
Use	Problems with use; Perception form the user; Volume; Previous situation; New requirements; Aligning use; Not use; Trading partners; Interdependence
User	Secure; Attitude towards the system; Knowledge about the system; Pressure from the customer; Uncertainty; Number of users; Lack of information; Mistrust; Resistance to change; Work overload

3.4.2 Memoing

Another important element of GT is the use of memos, which are defined as "the researcher's record of analysis, thoughts, interpretation, questions and directions for further data collection" (Strauss and Corbin, 1998, p.110). Throughout the open coding, we wrote memos as a way to sketch and note our ideas, reflections, and concepts in parallel to data collection and open coding. The focus of our reflections often were the actual wording or formulation used by interviewees, which we then interpreted during the analysis. Later we organize those memos and we wrote a paper (Rodon and Ramis-Pujol, 2006), which served as a preliminary validation of our findings, and a way to start presenting the findings of the research. During memoing we immerse ourselves in the data so that we embedded the narrative of the participants in the research outcome.

3.4.3 Axial and Selective Coding

Once we had all the codes organized into trees, we moved into 'axial coding' aiming to search a higher level of abstraction in our concepts. Given the amount of codes we obtained during open coding, we found difficulties in: 1) reassembling these codes, 2) specifying relationships between those codes, and 3) finding an underlying story in them. As such, we decided to analyze again all

the interviews, without generating new codes but writing memos, in order to develop a picture of what the data meant in a broader sense. Two general questions guided our analysis: what is happening in the data?, and what patterns are occurring in the data?.

Next we adopted a new perspective towards data: the paradigm model (Strauss and Corbin, 1990), which is an analytical tool to help contextualize the phenomenon by modelling the action and interaction strategies of the actors. Strauss and Corbin (1990) suggest using a coding family that consists of causal conditions, the phenomenon, the contextual conditions, the intervening conditions, the interactional strategies, and the consequences of these. We applied the paradigm model for our case and obtained the model in Figure 2. We, however, still considered that this model did not show a "moving picture" of what was going on in the implementation of the IOIS; the model mainly showed a "snapshot". We then examined how other IS papers (Crook and Kumar, 1998; Esteves, et al., 2003) had applied the paradigm model. These authors, however, also used it to show a static picture of the phenomenon. For instance, Esteves et al. (2003) used it to present the factors that affected the implementation of an ERP, and Crook et al. (1998) used it to develop a theoretical model of EDI use.

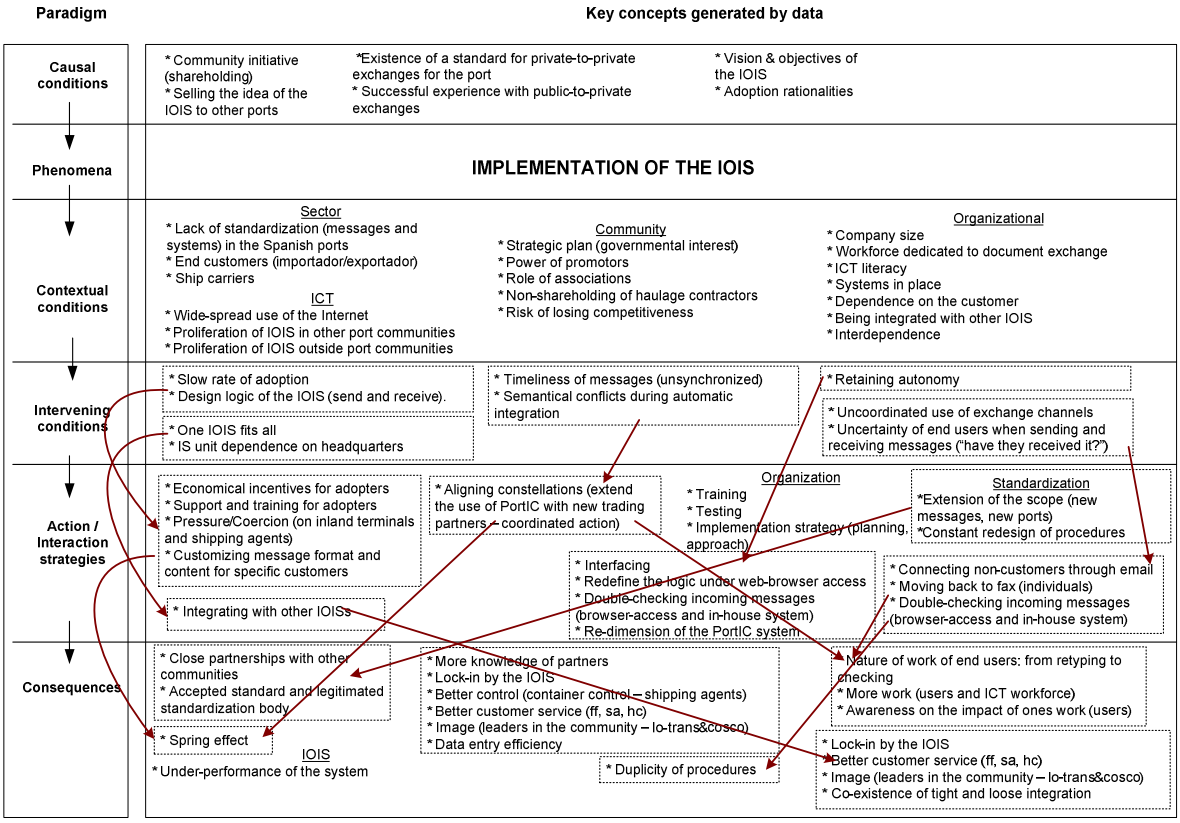

Figure 2: Paradigm model

As we were interested in a more dynamic view of the implementation of the IOIS, we then decided to adopt a simplified version of the paradigm model developed by Strauss and Corbin (1998) that consists of conditions, action/interaction, and consequences. Strauss and Corbin (1998) regard a process "as a series of evolving sequences of action/interaction that occur over time and space, changing or sometimes remaining the same in response to the situation or context" (Strauss and Corbin, 1998, p.165). Actions, which occur in response to changes in the context, may be "strategic" when they are "taken in response to problematic situations", or "routine" when they are "carried out without much thought" (Strauss and Corbin, 1998, p.165). That is, the authors conceptualize the process in terms of sequences or shifts in the nature of action and interaction between actors. Accordingly, rather than looking for properties of each code, which was what we had initially done in the axial coding, we purposely looked at action and noted "movement,

sequence, and change as well as how it evolves…in response to changes in context or conditions" (Strauss and Corbin, 1998, p. 167).

As our analysis of the empirical data on the basis of conditions→ actions→ consequences moved forward, our initial research question changed. The empirical data were telling stories that concerned the problems that firms faced when they integrated with the IOIS or in their daily use of the IOIS, as well as the responses that managers of the IOIS performed in order to help users adopt the IOIS. Thus our research problem had slightly changed from how the integration of pre-existing systems with the IOIS unfolded, to what was the role of IOIS management during the implementation process. We realized that the IOIS management acted in order to modify existing context –e.g. lack of use of the IOIS– or the consequences of their previous actions to adjust the IOIS to its adopters' environment. Following the analysis we did some more data collection aiming to validate the results.

Then we found five categories in our data which we interpreted as manoeuvres that managers of the IOIS performed in order to support the integration of adopting firms' systems with the IOIS and to enhance the use of the IOIS. The five categories that emerged were: "Maintaining adopters' autonomy", "Accommodating to unintended uses", "Managing the coexistence of exchange channels", "Agreeing on the operational use of the system", and "Balancing the degree of integration". Once we selected these five categories we limited the analysis only to those codes that were related with these categories.

Finally the five categories subsumed into a core category: "Managerial action in the implementation of an IOIS", which was the basis for the emergent theory. This core category concerned the set of actions managers might perform to support the integration of adopters' pre-existing systems with the IOIS and to enhance the use of the IOIS.

3.5 Diagramming: Presenting the findings

In GT the illustration of the theory is done mainly during axial and selective coding, when categories are created and related. Besides memos, Strauss and Corbin (1998) also suggest the use of diagrams as a tool to gain analytical distance from materials and to present the results. Diagrams are useful to sort out the relationships between categories that arise during axial and selective coding. Strauss and Corbin (1998), however, do not propose a systematic way to present diagrams, neither integrate them in GT; they suggest that the "analyst has to develop his or her own style and techniques" (Strauss and Corbin, 1998, p.223). In order to make up for GT's lack of illustration techniques we used action diagrams (Axelsson and Goldkuhl, 2004) to structure and report on the five salient categories that emerged from the coding process. Action diagrams helped us graphically represent the categories that emerged from applying the simplified version of the paradigm model (Strauss and Corbin, 1998).

In the action diagrams (see Figure 3 for an example) the diverse components of each category are related to each other as causal-pragmatic relationships. This means that the links between the different components in the diagrams are not deterministic, rather they are the result of interpretations of the actors (Axelsson and Goldkuhl, 2004). In the diagrams, we use different labels to indicate the role of each component within the diagram: preconditions, actions (performed by the IOIS management), and consequences. Consequences may be intended or unintended, and primary or secondary. An unintended consequence arises when an action that is performed with the intention of producing one consequence produces a different one –conflicting, negative or positive. A primary consequence is the immediate intended result of an action. A secondary consequence is the result of a primary consequence, and can be either intended or unintended.

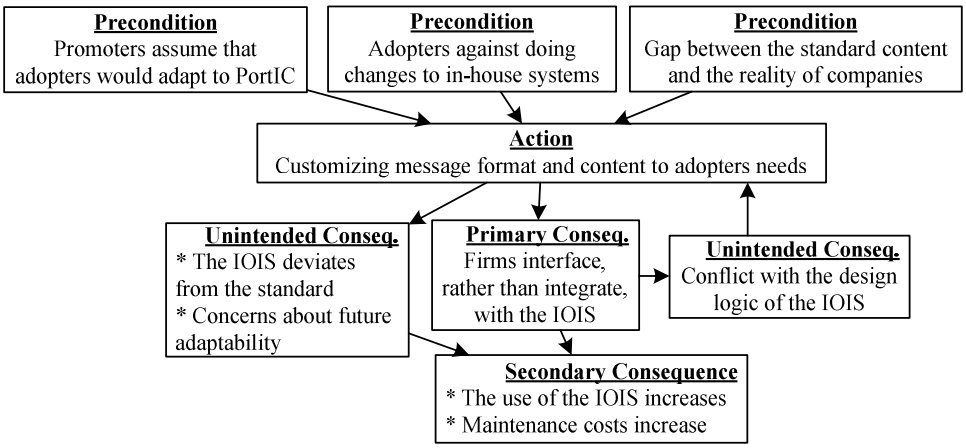

Figure 3: Action diagram for the category "Maintaining adopters' autonomy"

3.6 Theoretical matching and generation

Since the five categories emerged we started scrutinizing the literature for models, frameworks, or theories that might be relevant to our findings and thus enhance the theoretical sensitivity. Thanks to our initial IOIS literature review, we realized that the role of management in the process of IOIS implementation was an unexplored area in the IOIS literature. We then confronted the five categories that emerged from the analysis with three other streams of literature (Figure 4): mutual adaptation (Leonard-Barton, 1988), organizational change (Orlikowski and Hofman, 1997), and emergent strategy (Mintzberg, 1994) literatures.

Organizational change literature (Orlikowski and Hofman, 1997) tells us that in their daily operation the IOIS management has to deal with emergent changes –i.e. unexpected user appropriations of the system. Such emergent changes create unforeseen conditions and reveal misalignments (Leonard-Barton, 1988), which trigger managers to perform adaptive responses (opportunity-based changes) in order to reinforce or attenuate them; in turn, as managers respond, new unintended outcomes and changes may emerge. We group the adaptive responses that arose from the case into five managerial manoeuvres (our five categories). Finally, we observe that these manoeuvres converge into two strategies in action, also referred as emergent strategies (Mintzberg, 1994): attract users to bootstrap the IOIS, and keep the IOIS adaptable.

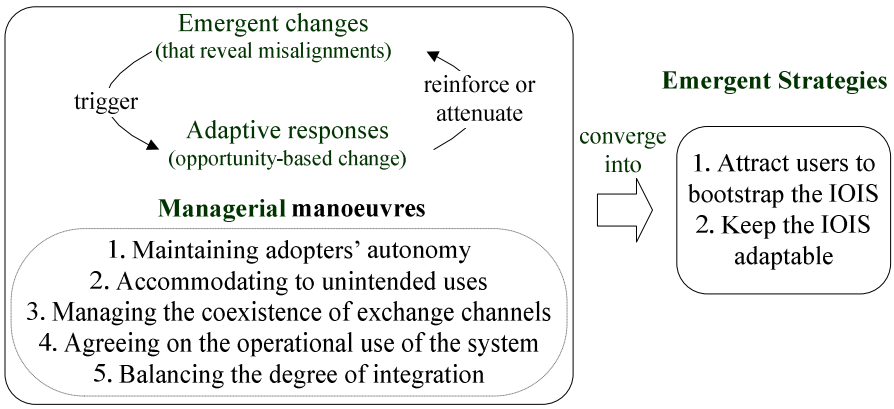

Figure 4: Process model that shows the emerging theory

Through theoretical matching and generation we were able to: 1) adapt the results of the GT study, and 2) provide a model that complements prior IOIS literature, which regards the implementation process as being rationally planned and usage follows as expected. This model, which is grounded in the behaviour, words and actions of a set of professionals in a specific context, offers a plausible explanation of the phenomenon under study. It is a process model that shows the evolving nature of IOIS implementation

4. Discussion and Conclusion

Having conducted the aforementioned GT study we highlight the following points, which result from the reflection of our experience.

- Having some knowledge about the research setting and the research problem before a GT research starts is advisable. By conducting several empirical studies before we started the GT study we were able to quickly immerse into the research context, which helped us define the initial sampling and minimize the jargon problems during the analysis. In addition, although we conducted a literature review prior to starting the GT study, we did not bring about any hypothesis or theoretical models to our GT research. The reason is that one of the outcomes of the review was that our research problem was an unnoticed area for prior studies. Moreover, in the later phases of the research process this literature review helped us enhance the theoretical sensitivity, and understand when new theory emerged.
- At the outset of open coding, analysis was unfocused. As a result, we obtained a large amount of open codes, which in turn, increased the complexity of the data analysis. Likewise, we found difficulties in scaling up the codes into more abstract codes, in finding properties and categories, and in giving names to codes. Sometimes the names we used were to abstract, thus they lacked precision; other times the names were too tied to the data, thus they lacked the status of a category. We consider that a researcher's overemphasis on identifying codes without relating them and developing theoretical codes, is a normal and sometimes inevitable pitfall in the initial stages of the analysis. However, as we have experienced, the researcher may overcome this pitfall later stages of the coding process.
- The researcher has to approach coding with an open mind, flexibility, and creativity. First, coding has to be performed as much as possible without predetermined ideas. The researcher has to be open mind when making sense of the data. He has to avoid looking for confirmation of his previously established ideas in the data gathered. Moreover, the researcher usually starts coding with a vague idea of the research problem and question. Later as the research process moves forward the researcher is able to fix the research question.

  Second, although the process of creating categories is mainly creative, the categories have to be grounded in data. In our case, even though during axial coding we codified again all the empirical data from scratch, the open codes helped axial coding as they facilitated our abstraction process. Memos and diagrams became a relevant vehicle for our creativity.

  Third, researchers should approach coding with flexibility. As Strauss and Corbin (1990) recognize, researchers have to be flexible in the sense that "while we [Strauss and Corbin] set these procedures and techniques before you, we do not wish to imply rigid adherence to them" (p. 59). It is the interpretation and flexibility of the researcher what really matters. Therefore, although GT provides with a set of procedures for coding, comparing, categorizing, etc, which may seem quite mechanistic, the analytical process is very interpretive in nature and somehow flexible in use.
- Theoretical sensitivity and matching occurs at two levels. At one level, theoretical sensitivity is enhanced by constantly reading in the same and other areas of research. At the other level, the development of concepts directs researcher's attention to specific literature. For the later to occur it is useful that you share your findings with colleagues from your or other fields, for instance, in workshops and conferences. In our case we started incorporating external literature once the five categories started emerging.
- Finally, a GT study is very time- and resource-consuming, specially the processes of transcription, codification and constant comparison, thus any tool that supports the research is advisable. For instance, computer software may ease the process of cross-checking code generation; that is, they reduce the clerical work. Likewise, the software facilitated the writing process as it was easy to browse over the amount of codes we got. However, these tools do not substitute the researcher having to make sense of the data, because the abstractions are mental activities which cannot be formalized (Goulding, 2002).

This paper outlines the practicality of using GT and provides a practical understanding of how GT can be used, which may serve as a guidance for novice researchers. GT has been applied to provide a full in-depth descriptive account about the implementation of an IOIS in the Seaport of

Barcelona. The paper also shows how to adopt the paradigm model (Strauss and Corbin, 1998) in order to develop a process model of IOIS implementation.

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Appendix 5

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The Role of Emergent Strategies in Managing the Implementation of an Industry IOIS

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ABSTRACT

A dominant implicit assumption in the literature on inter-organizational information systems (IOIS) is that the implementation of the IOIS is rationally planned, it goes according to a plan, and use follows as expected. Contrary to this assumption, this empirical paper shows that the management of IOIS cannot only be conceived as pre-defined planned intervention, but also as a form of reaction and response to situational demands and users' behavior. IOIS emerge from users' enactment and reinforcement of the system, which managers have difficulties in foreseeing and cannot avoid. We present a case study about the implementation of an industry IOIS in the Seaport of Barcelona. Using Grounded Theory method, we have found five maneuvers that the IOIS management undertakes during and following the implementation in order to encourage and support the use of the IOIS. Next, drawing on the literature of mutual adaptation, organizational change, and emergent strategies, we interpret these managerial maneuvers. Finally, we show that the five managerial maneuvers converge into two emergent strategies: attract users to bootstrap the IOIS, and keep the IOIS adaptable.

Keywords: IOIS, Implementation, Emergent Strategy, Adaptation, Change, Grounded Theory

1 Introduction

Since its inception, industry inter-organizational information systems (IOIS) –also called electronic trading infrastructures, exchanges, hubs, etc.– have increasingly constituted a key element of electronic commerce in many industries (Christiaanse and Rodon, 2005; Markus, et al., 2006). For instance, Covisint in the automotive industry, Elemica in the chemical industry, INTTRA in the ocean shipping industry, or MISMO in the US Mortgage industry. In general terms, an industry IOIS is an intermediary between firms across an industry aiming first to standardize their inter-firm processes and later establish electronic links between the individual information systems in order to streamline the processes of the individual firms as well as of the industry as a whole. This paper studies an IOIS that is set up, organized and used by firms of the same industry (Damsgaard and Lyytinen, 2001a; van Baalen, et al., 2000). Since such IOIS are driven by their users, short-term economical performance is not always a target. Rather a major target for the industry IOIS management is to achieve a widespread adoption and use of the IOIS. On the basis of this premise, the present paper explores the actions that the IOIS management may perform in order to foster the use of the IOIS among the firms of the industry. This paper is concerned with managerial action in practice. Next, we turn into existing literature to look for studies that have deal with this research problem.

There is an extensive literature on IOIS (see Robey et al. (2006) and Ramanathan and Rose (2003) for reviews on IOIS literature) that has proposed a set of factors to explain the antecedents of adoption –i.e. the adoption decision–, and the consequences of adoption –i.e. the extent of use or the perceived benefits. These studies have developed primarily factor-based models based on diffusion of innovations theory (Rogers, 1995) and institutional theory (DiMaggio and Powell, 1983). These models (Iacovou, et al., 1995; Teo, et al., 2003) capture aspects of the external environment (e.g. competitive pressure, partners power, extent

of adoption), the organization (e.g. financial resources, IT readiness), the characteristics of the innovation (e.g. compatibility, cost), and the perceived benefits. Other researchers (Damsgaard and Lyytinen, 2001b) have focused on the role of industry associations in the diffusion of EDI. The authors identify six institutional measures (knowledge building and deployment, subsidy, innovation directive, standard setting and mobilization) that may be applied by trade associations in order to foster the adoption and diffusion of the IOIS. These studies' main focus, however, is not the processual nature of implementation; consequently, they do not report on the intricacies that arise during the implementation and post-implementation (Kurnia and Johnston, 2000; Rodon, 2006). Although the former factor-based literature may be helpful for studying our research problem, we consider that a processual approach (Markus and Robey, 1988) that looks for sequences of events, adaptations, adjustments, appropriations and reinventions of the technology that occur during and after the implementation process, and that describe how things change and unfold during the implementation of the IOIS, may be appropriate and complement prior factor-based literature.

On the other hand, prior IS literature has already examined the role of IS managers as agents of organizational change. Markus and Benjamin (1996) consider IS change agentry as part and parcel of IS work. The authors present three different models of change agentry (the traditional IS change agent, the facilitator, and the advocate) and state that the ideal IS role may actually combine the three models of change (Markus and Benjamin, 1996). Likewise, other papers have adopted a human agency perspective to study the behavior of the individuals in the use of an enterprise resource planning system (Boudreau and Robey, 2005), or have studied the user cognitive and behavioral actions in order to cope with information technology events that occur in their work environment (Beaudry and Pinsonneault, 2005). These studies, however, do not focus on the strategies adopted by management, neither the

systems object of study are IOIS. This paper fills this gap by exploring the actions that managers of an IOIS carry out in order to foster and support the integration and use of an IOIS among its potential adopters. That is, we focus on managerial actions that influence how the technology is put to use. We look at these actions drawing on the literature of mutual adaptation (Leonard-Barton, 1988), organizational change (Orlikowski and Hofman, 1997), and emergent strategy (Mintzberg, 1994). On one hand, implementing an IOIS may be viewed as a process of mutual adaptation (Leonard-Barton, 1988) among the organizational structures, work processes, skills, work culture and information systems of the diverse firms. On the other hand, IOIS are open-ended technologies in the sense that they may be locally adaptable and used in different ways, hence the set of possible actions during the use process is broad. Most of the previous IOIS literature, however, has overemphasized the implementation and use as rationally planned (Mintzberg, 1994), thus marginalizing the potential of emergent and opportunity-based change (Orlikowski and Hofman, 1997). In this paper we demonstrate that planned changed accounts for only a limited part of the total change and that emergent and opportunity-based change is very relevant in the management of IOISs.

This research uses Grounded Theory method to explain how the IOIS management fosters the use of the system. We conducted a case study, which follows the principles of grounded theory in accordance to Strauss and Corbin (1998), about an IOIS in the Seaport of Barcelona. The use grounded theory is justified as it allows us to focus on context-based, processual descriptions of the implementation (Myers, 1997) as well as the actions that managers of the IOIS perform in fostering the integration of pre-existing systems with the IOIS and its later use. The case examines: 1) the events and opportunities (which may result users actions) that arise during the integration and use of the IOIS, 2) the actions that managers of the IOIS intentionally and deliberately introduce in response to the events and

opportunities that emerge; and 3) the consequences of the deliberate actions that managers introduce. We pay attention to the IOIS management in the process of change. These managers are the ones interpreting the events and opportunities, and based on those interpretations they frame their action. Therefore, we adopt a pragmatic approach in two senses. First, we are interested in managerial action and change in practice. Second, we are interested in how-tos which might contribute to an improvement of the IOIS management.

The structure of the paper is as follows. In section 2 the research methodology is introduced. Section 3 presents the case study background. Section 4 presents the research results. Section 5 discusses the results and integrates them with insights from mutual adaptation and organizational change literature. Lastly, we conclude with the contributions.

2 Research Methodology

In this study we adopt an interpretive mode of enquiry that has its roots in symbolic interactionism (Blumer, 1969). Symbolic interactionism asserts that "the essence of society lies in an ongoing process of action - not in a posited structure of relations. Without action, any structure of relations between people is meaningless. To be understood, a society must be seen and grasped in terms of the action that compromises it" (p.71), as quoted by Goldkuhl (2005).

Our aim is theorizing from process data, so we focus on "microlevel to explore the interpretations and emotions of different individuals or groups living through the same processes" (Langley, 1999, p. 700). Consequently, we use Grounded Theory (GT) method because it allows us to look for "repeated patterns of happenings, events, or actions/interactions that represent what people do or say…, in response to the problems and situations in which they find themselves" (Strauss and Corbin, 1998, p. 130). In addition, GT provides a set of established guidelines both for conducting data collection and analysis (Goulding, 2002), which offer us a sense of security when delving into the unknown territory

that becomes IOIS management. Finally, GT is an established and credible methodology in the IS field (Crook and Kumar, 1998; Orlikowski, 1993; Urquhart, 1999).

Strauss and Corbin (1998) state that GT is "an action/interactional method of theory building". Accordingly, these authors develop an action paradigm model to explain a phenomenon in terms of conditions, actions/interactions and consequences. This paradigm model is an analytical tool to integrate the conditions, or structure, in which categories are situated, with the sequences of action/interaction processes that pertain to the phenomenon. Such action/interaction processes "occur over time and space, changing or sometimes remaining the same in response to the situation or context… Action/interaction evolves or can change in response to shifts in the context. In turn, action/interaction can bring about changes in the context, thus becoming part of the conditions framing the next action/interactional sequence" (Strauss and Corbin, 1998, p.165).

2.1 Data collection

Our research relies upon an interpretive case study (Walsham, 1995) carried out in the Seaport of Barcelona. The empirical work was conducted by the first author over a 9-month period (March 2005-November 2005). Data collection consisted of semi-structured interviews (27 interviews, each about 1 hour long; see Table 1), meeting minutes, document analysis, company visits, and attending meetings.

In the interviews we collected data about: the companies, the informants' background, their experience in the company, their vision on the IOIS, and about the relevant events and problems that shape they integrate with and use the IOIS. Some of these events and problems were repeated by more than one informant, thus we could compare the different interpretations. We traced those events, the actions in response to those events adopted by the different actors involved, especially those of the IOIS management, and the consequences of those actions.

Table 1: Summary of the interviews conducted

Type of firms	#Firms	#Interviews	Position
Shipping agent	2	6	CEO, IS manager, Operations manager, user
Freight forwarder	4	6	Maritime manager, IS manager, user
Inland terminal	1	3	CEO, Operations manager, IS manager
Hauler	2	4	CEO, Operations manager, IS manager
Port Authority	1	3	IS manager, Analyst
IOIS	1	5	CEO, Marketing manager, Analyst

2.2 Data analysis

Consistent with the GT approach, our data collection, coding and analysis occurred iteratively. As interviews were transcribed they were coded and analyzed. This process gave new insights into the research, helped to formulate new questions in subsequent interviews and guided us on the most appropriate informants.

At first, data were examined line by line and coded based on the terms used by informants (open coding). Memos were also written, and codes were grouped and organized into trees. Next, we proceeded with the “axial coding” and built the categories. Instead of looking for properties of each code and category, we used the “coding for process” approach (Strauss and Corbin, 1998). That is, we purposely looked at action and noted “movement, sequence, and change as well as how it evolves (changes or remains the same) in response to changes in context or conditions” (Strauss and Corbin, 1998, p. 167).

2.3 Theory modeling

In GT the illustration of the theory is done during axial coding when categories are created and related. During axial coding, the researcher develops a category by specifying the conditions that gave rise to it, the context in which it is handled, managed and carried out.

These conditions, contexts, strategies and outcomes tend to be clustered together and the connections may be hierarchical, linear or recursive (Goulding, 2002). Although Strauss and Corbin (1998) suggest the use of diagrams to present the results, they "are not systematically shaped and not built in the methodology in a proper way" (Axelsson and Goldkuhl, 2004). In order to make up for GT's lack of illustration techniques we use action-oriented diagrams (Axelsson and Goldkuhl, 2004) to present our findings from the case.

Five salient categories emerged from our axial coding: "Maintaining adopters' autonomy", "Accommodating to unintended uses", "Managing the coexistence of multiple exchange channels", "Agreeing on the operational use of the system", and "Balancing the degree of integration". We interpreted these categories as maneuvers adopted by the IOIS management in order to foster the integration and use of the IOIS. We use action-oriented diagrams (Axelsson and Goldkuhl, 2004) to structure and report on these categories. The different components of each category are related to each other as causal-pragmatic relationships in contextual action-oriented diagrams. This means that the links between the different components in the diagrams are not deterministic, rather they are the result of interpretations of the actors (Axelsson and Goldkuhl, 2004).

In the diagrams, we use different labels to indicate the role of each component within the diagram, such as preconditions, actions (performed by the IOIS management), and consequences. Consequences may be intended or unintended, and primary or secondary. An unintended consequence arises when an action that is performed with the intention of producing one consequence produces a different one (conflicting, negative or positive). A primary consequence is the immediate intended result of an action. A secondary consequence is the result of a primary consequence, and can be either intended or unintended.

3 Case background

PortIC is an IOIS at the Seaport of Barcelona that was launched by mid-1999 in order to coordinate the activity of the firms in the port's landside transport network (which encompasses the transport of goods between the port and any place in the hinterland, and vice versa) and to integrate all the information being exchanged between the various port agents. PortIC was expected to integrate the different port agents in the Port Community with two main goals: first, reduce the operational costs of port agents, and second, provide transparency to the document exchanges and to the movements of cargo in order to reveal inefficiencies. To achieve these goals PortIC would: 1) implement the standard for data exchange previously defined by TelFor[1]; 2) capture the information produced in any exchange within the Seaport, thus avoiding the need to retype data, substituting paper, and reducing the errors and processing costs; 3) centralize all the information of the Seaport; and 4) provide real-time information to facilitate the documentary track and trace of goods.

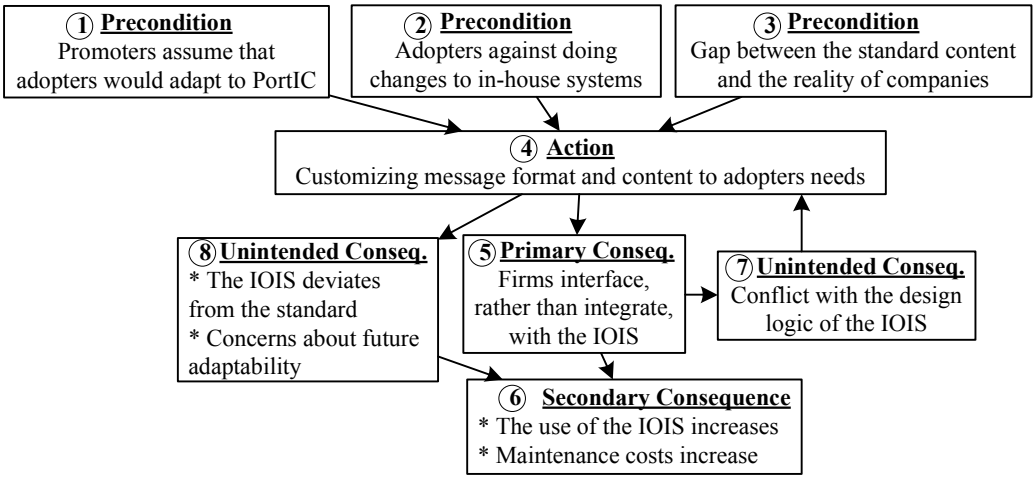
PortIC is characterized by the fact that it is owned and used by the members of the port community (the Port Authority, as well as private companies represented by their trade associations: stevedores, freight forwarders, clearing agents, shipping agents and the Chamber of Commerce of Barcelona). These stakeholders set up a company, namely Portic Barcelona, SA (PortICCO) in 1999, to manage the operation of PortIC. The company offered three type of services: 1) private-to-public exchanges: exchanges between a private organization and a public body –cargo manifests, customs request, etc.; 2) private-to-private

[1] TelFor (Telematic Forum) is a standardization committee in charge of standardizing the inter-organizational processes as well as the syntax and semantics of the messages exchanged in those processes within the Seaport of Barcelona.

exchanges –booking, gate-in notification, etc.; and 3) information services that allow the real-time documentary track and trace of goods. Although PortIC implementation was to great extent completed during 2000, the number of port agents adopting and using the IOIS was much less that PortIC promoters and management had planned. Potential adopters did not mobilize as expected. There was not a minimum installed base of users. From that moment managers of PortIC have struggled in order to bootstrap the IOIS. Next we present five managerial maneuvers that PortIC management carried out, during the period 2001-2005, in order to foster the integration and use of PortIC. We use action-oriented diagrams to graphically present these managerial maneuvers. In addition, we build a narrative for each maneuver based on our interpretation of the goals, actors, and their interventions.

4 Research Results

4.1 Managerial maneuver 1: Maintaining adopters' autonomy



1, 2 and 3. Preconditions. There was a common belief among the promoters of PortIC that adopters would introduce organizational changes to take advantage of PortIC when they integrated with it.

"PortIC is a system that is easy for companies to use. But this does not prevent the fear of the unknown in the form of internal change and a change in the way we think about our daily activity" (CEO of the Port Authority of Barcelona)

However, most of the firms in the study merely saw PortIC as a glorified postman, receiving messages and forwarding them on to the right target. From the outset, the organizations in the study did not introduce changes in their organizational structures, and avoided making changes in their internal physical and documentary processes. They saw PortIC as a tool that simply replaced the fax or former EDI systems they had, and they were not willing to implement any change to their business processes. Moreover, some firms complained about the flows and content of some of the messages initially defined in the standard by TelFor and implemented by PortIC. They considered those business processes differed from their in-house business processes.

4. Action. Then TelFor and PortICCO decided that the standard and PortIC would adapt to the demands of adopters. For instance, in the case of exports, TelFor members agreed that truck drivers would not need to show any paper-based documentation to enter the inland terminal providing that the hauler had previously specified the driver in electronically submitted 'pre-arrival notification'. However, once PortIC had implemented the procedure, inland terminals objected to it arguing they had never worked that way. Then PortIC made some changes, which lay outside TelFor's scope, to persuade inland terminals.

"There was initial resistance from inland terminals to accept this procedure. They argued that with the 'acceptance order' message was enough. But that means that the truck driver will have to bring a paper-based copy of the 'acceptance order'. Finally we agreed with inland terminals that haulers could submit the 'pre-arrival notification' and that PortIC would translate that message into the 'acceptance order' format before submitting it to the inland terminal… In that way the inland terminal did not have to adopt a new procedure for pre-arrival notification messages." (A manager at PortIC who participates in TelFor)

5. Primary Consequence. This accommodation of PortIC to adopters needs allowed the latter to avoid making changes to their business processes and databases. Interoperability was mainly accomplished through conversion tables but never by changing their data models.

6.- Secondary consequence. A secondary consequence of the action was that some firms, which had agreed to integrate with PortIC several years before but had never been active users, boosted the use of the system. There was an increase in the number of messages exchanged. On the other hand, the maintenance costs of PortIC increased as more customizations were implemented.

7. Unintended consequence. Once firms started interfacing with PortIC they realized they required information to complete messages that was not always stored in their databases. However, the design logic behind PortIC had been that of a virtual clearing house. PortIC stored data from incoming messages and forwarded them to the specified target. That meant that, in some cases, firms were forced to store data from incoming messages that they had never used before but that they required in order to complete a message they had to generate later. These firms considered that although from the outset they had agreed with the design logic of PortIC, they later realized it should have been different.

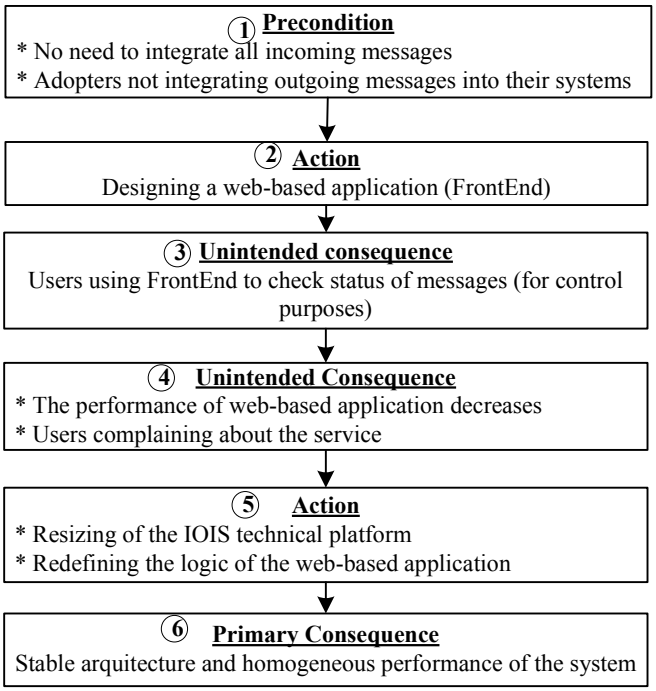
In such case, PortIC could add some value if it avoided firms retyping some data that they did not have at that moment or which they had already previously sent (action 3). Later, PortIC accommodated to this requirement. For instance, an IS developer from an inland terminal notes,

> "When I send a 'gate-in notification' message, if that message corresponds to an 'acceptance order' of a dangerous good, the CODECO guide defined by EDIFACT forces me to use a free text within the GID segment. This bugs me, because I do not store free texts in our database. The fact that this free text field is compulsory makes no sense. In our business [inland terminal] this free text is of no use. Thus I have problems in generating the CODECO message…As PortIC had this free text in the database, they [PortIC] implemented a conversion table that

allows me to get the free text through the ‘acceptance order’ identifier, which is in my database. We just send the ‘acceptance order’ identifier and PortIC does the conversion”.

8. Unintended consequence. Finally, as some of the changes made by PortIC’s managers had not been approved by TelFor, PortIC implemented some procedures that deviated from what the standard laid down. Moreover, the customization of the IOIS to current customers has diminished the capacity of the IOIS to adapt to future changes. In addition, PortIC’s maintenance costs have increased (secondary consequences 5) given that any new measure approved by TelFor requires customization of PortIC support.

4.2 Managerial maneuver 2: Accommodating to unintended uses



1. Precondition. PortIC was designed in order to give every firm access regardless of the system they had in place. Hence PortIC was based on the Internet: firms could send and receive messages in the formats defined by TelFor (EDIFACT, XML, and flat file) by using various services (ftp, oftp, e-mail). Companies should be able to use PortIC without having to

develop their applications to send and receive the messages from PortIC, or to integrate their in-house systems with PortIC.

2. Action. Accordingly, PortICCo designed a web-based application, namely FrontEnd that ran on a PC and could be used for the generation and reception of messages.

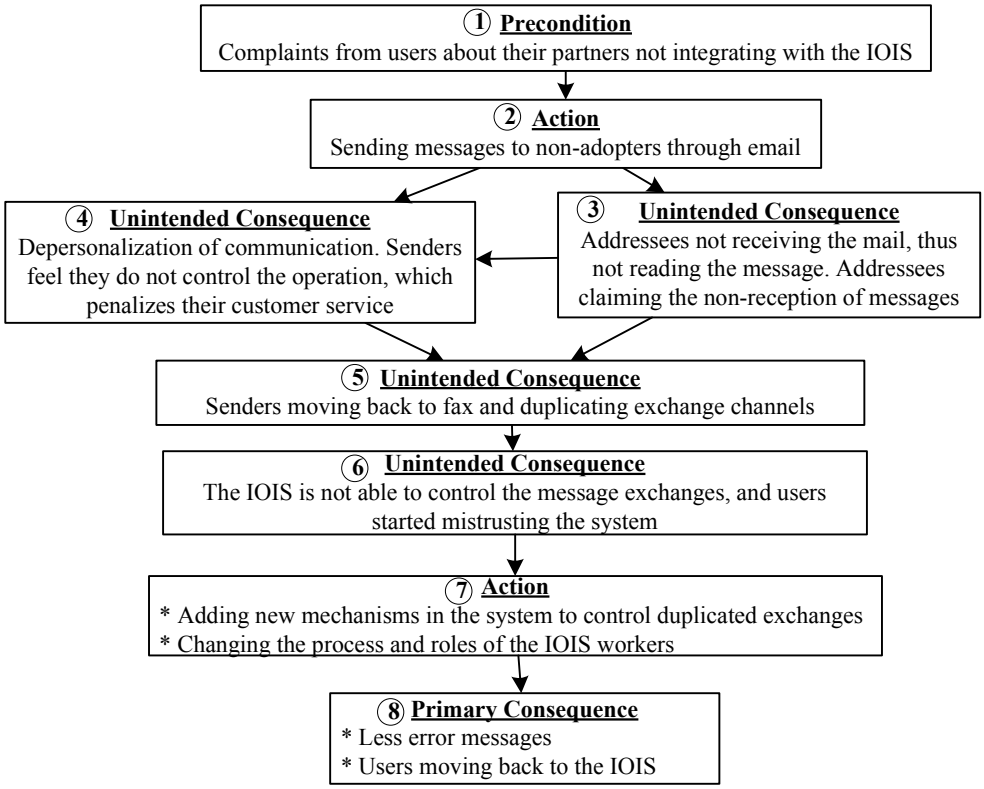
3. Unintended consequence. However, things have turned out differently. Most of the firms in the case are using their in-house applications for message generation, and they always use FrontEnd to check the status of their outgoing messages (i.e. to check whether those messages have reached PortIC and the final addressee), for the reception of messages (even though those messages are automatically integrated with internal systems), and for printing purposes (i.e. when a shipping agent prints a previously sent transport order and gives the paper document to the hauler). There are two reasons for this use, which was not foreseen by FrontEnd's designers. First, most of the users feel more confident doing a double check on incoming messages: FrontEnd on one side and their in-house application on the other. They look at FrontEnd and when there is a new event –i.e. new message- they enter their in-house application to check the changes. Second, systems developers of these companies do not want to do extra work by integrating all incoming messages, given that they consider some messages are of no value to their companies and their managers have not demanded them to integrate those messages into their firms' systems. They consider that the cost of manually processing these incoming messages by the end users is much less than the effort of integrating them into their systems.

4. Unintended consequence. The increasing use of FrontEnd progressively worsened its performance, which has resulted in users complaining about the service.

5. Action. Consequently, PortIC managers first increased the processing capacity of the system. Second, they considered to redesign the logic of FrontEnd in order for users to easily and rapidly view messages.

6. Primary consequence. The first results from resizing the hardware have been: better response times of the FrontEnd, and a perception by users and developers alike that the system is more stable than hitherto.

4.3 Managerial maneuver 3: Managing the coexistence of multiple exchange channels



1. Precondition. The initial adopters complained to PortICCO because only few of their partners, which in some cases represented less than 5% of their exchanges, were integrated with PortIC. This meant that those adopters had to maintain several systems (e.g. PortIC, fax, other EDI systems) to interact with partners.

2. Action. As a result of this request, TelFor members decided to add a new qualifier to the FTX (free text) segment of the EDIFACT messages for the e-mail address of the addressee. This allowed PortIC adopters to send messages the same way regardless of the addressee's identity. They did not have to check if the addressee had adopted PortIC. PortIC would do that job. In the event that the addressee was a non-adopter, the system would

forward a message to the e-mail address instead. Most of the non-adopters gave the e-mail of the sales manager or the IS manager for contact purposes but not of the person in charge of message processing (usually a clerk in the import, export or transport departments).

3. Unintended Consequence. First, the result was that the marketing and IS managers usually did not forward the message to the right person inside their companies, did not read it or deleted it by mistake. Later on, the clerks (addressees), who should have received the message, called the sender to chase things up.

4. Unintended Consequence. On the other hand, as messages were not directly received by the right person (the clerk who had to process it), senders felt that the communication had become depersonalized. Senders felt uncertain about the communication status; in addition they considered they had less control over the business operations, which, in turn, had a negative impact on the service they provided to customers.

5. Unintended Consequence. These two consequences led to senders mistrusting the PortIC system and moving back to prior systems (i.e. fax) when they had to interact with non-adopters of PortIC. The result was that sometimes users sent messages through several channels, first via PortIC and later when there was a problem they resent the message via fax. Thus the entire workflow was partially fulfilled through PortIC and partially through other channels (fax, e-mail, phone or paper-based).

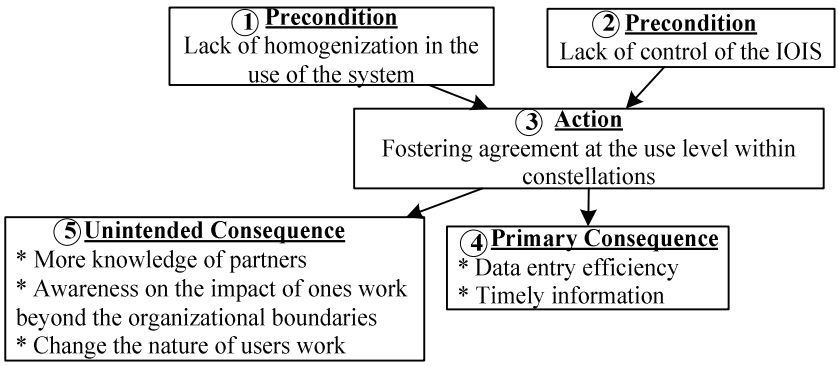
6. Unintended Consequence. A set of problems was reported as a result of this duplication of messages. For instance, some shipping agents complained to PortIC because they sometimes received duplicate ‘gate-out notification’ messages from depots –messages with the same ‘release order’ number. After some analysis at PortIC, they discovered that the reason was that haulers, in order to make their work easier and faster, made photocopies of former ‘release-order’ messages and gave them to depots. Later the depot in order to submit the ‘gate-out notification’ used the ‘release-order’ number that the hauler had used. As PortIC

had no proof of haulers having sent the message by paper, PortIC could not coordinate and synchronize the flow of exchanges. PortIC was not able to track the status of document exchanges, which sometimes generated error messages to the parties who then got confused, thus making PortIC's adopters even more distrustful.

7. Action. PortIC managers responded by introducing two measures. First, they added automatic mechanisms in the application to control inconsistencies over flow of messages. Second, they defined new working procedures and new roles within PortICCO to ensure that any company, who was not integrated with PortIC but wanted to receive messages by e-mail, had internally organized their procedures so that the right addressee (clerk) was the one receiving the message. This new role at PortICCO monitored those new adopters till there were no errors in the exchanges.

8. Primary Consequence. The result has been a decrease in the number of error messages generated by PortIC as a result of inconsistent exchanges, and a move back to PortIC by some users to send their messages.

4.4 Managerial maneuver 4: Agreeing on the operational use of the system



1 and 2. Preconditions. The way companies use PortIC depends not only on how they integrate with PortIC but also on how their partners integrate and use PortIC. For instance, users are accustomed to their way of filling out messages; sometimes this means that they do not use all the fields or combine different fields in one. When fax is used, the addressees of

the message retype the message in their systems. In doing this task they interpret the content of the message and if there is a mistake they correct it or call the sender. The fact that incoming messages are automatically integrated with internal systems, means that messages are syntactically correct, however, data may be located in other fields, rendering the message semantically incorrect. The IOIS (PortIC) has no way of detecting these inconsistencies (assuming the messages follow the standard syntax). Therefore, the way a sender (human or system) generates a message may hinder the receiving company from automatically integrating that message into his in-house systems.

> "The problems appear when we have to integrate incoming messages automatically with our systems. For instance, if a shipping agent [the sender] types the address and city where we have to pick up a container, in the address field of the EDI message, instead of typing the city in the city field, or if he types a wrong postal code…[then] our system will not be able to compute the costs of a service automatically, and the message will require manual checking." (Manager of a hauler)

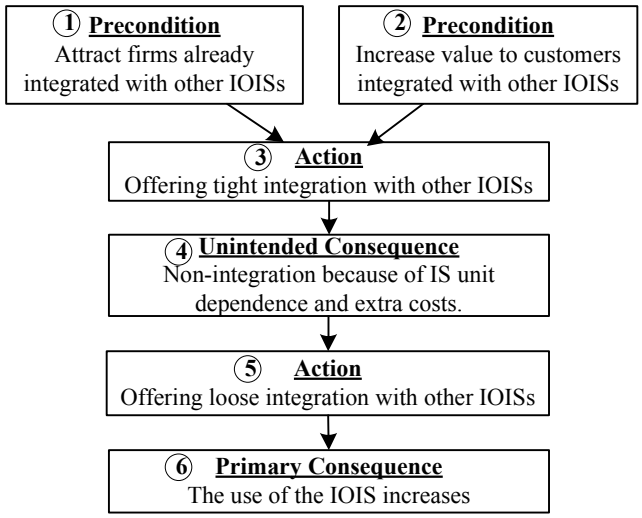
On the other hand, as we have seen in managerial maneuver 3, when all the messages do not pass through the IOIS, for instance, because a user decides unilaterally to send a message by fax, then it is impossible for the IOIS to control and monitor the message exchanges. The IOIS may even generate error messages because the workflow is incomplete.

3. Action. These two anomalies in the functioning could be largely solved if the different users (that belong to different companies) agreed on the way they fill and the channels they use to exchange messages. To overcome these situations, PortICCO created groups of firms of different type (i.e. inland terminal, shipping agent, and hauler). PortICCO held meetings with these firms in order to standardize the message exchange within the group. They agreed on the filling of messages.

4. Primary consequence. This agreement at the level of use within the group of firms has helped reduce the number of data entry errors, and led to a greater perception that information is received on-time.

5. Unintended consequence. On the other hand, this action has caused unintended consequences: Firstly, end users have more and better knowledge about the work of their partners, as well as about the impact of their actions on their partners. Secondly, the integration with new partners is now easier, because after each agreement, developers get some knowledge that will prove in subsequent integration projects. Thirdly, when fax was the normal exchange mechanism, addressees had to retype messages; during the retyping they interpreted the content of the messages and if there was a mistake they corrected it. Once an incoming message is integrated with the internal systems, workers do not have to retype it but check whether it is semantically correct. Therefore, the nature of work has changed, from data entry to message checking on the screen. Some of the companies in this study have had to train their employees into the new way of working.

4.5 Managerial maneuver 5: Balancing the degree of integration



1 and 2. Preconditions. PortIC aims to be a solution for a context with clear boundaries: the inland transport of goods in the Seaport of Barcelona. PortIC management,

however, wanted to increase the value to existing customers as well as attract new ones, who were users of other IOIS.

3. Action. Accordingly, in 2004, PortIC managers suggested to some of the multinational firms operating in the seaport that PortIC would integrate with their preferred IOIS. For instance, they first approached a shipping agent (ShAg1). ShAg1 mainly uses two information systems: a local system and the corporate system, which is hosted at the headquarters of the sea carrier in China. Every ten minutes, ShAg1 downloads information from the corporate system, and once a day ShAg1 uses ftp to upload some other information to the corporate system. However, the headquarters do not permit the ShAg1 to upload messages to the corporate system automatically. As a result, clerks of ShAg1 have to log into the sea carrier's corporate system and manually enter those messages that have to be processed in real-time at company headquarters (the case of bookings and shipping instructions). On the other hand, ShAg1 has an interface between its local system, an IBM AS/400, and PortIC. Some of the incoming messages from PortIC are automatically processed and integrated into the local system, while others (bookings and shipping instructions) are printed and re-typed into the corporate system. By mid 2004, as the sea carrier was integrated with CargoSmart (an IOIS for the ocean container transportation industry), ShAg1 and PortICCO agreed that PortIC could forward any booking or shipping instruction message to CargoSmart, which in turn will submit those messages to the corporate system of the sea carrier. That way, ShAg1's clerks would avoid re-typing those messages in the corporate system.

4. Unintended Consequence. At the end of 2004, PortICCO started sending test messages to the IS unit at the headquarters of the sea carrier in order to test if the structure and content of messages fitted. However, PortICCO never received any answer. Later the IS manager of ShAg1 recognized,

> "We understand that our headquarters [the sea carrier] are not interested in receiving these messages through CargoSmart, because there is a cost for the sea carrier. In the beginning we did not understand why the headquarters was not positive about that. But finally we understood that it was because of the extra costs. [The sea carrier would have to pay CargoSmart to receive those messages through CargoSmart. By contrast, retyping of messages by ShAg1 in Barcelona did not represent any extra cost for the sea carrier.]"

On the other hand, the two biggest freight forwarders in the study refused to integrate their systems with PortIC. These companies have a centrally managed IS organization for the sake of ICT and business process standardization. This unit manages the corporate system as well as the integration of this corporate system with other IOISs (i.e. GT Nexus and Inttra) or preferred customers' corporate system. This central unit, however, was not based in the port of Barcelona. On the other hand, the IS local unit of these organizations is intended to provide only support, for instance, in terms of ICT maintenance and user training. Any extra local requirements dealing with business process, message format or ICT architecture, have to be submitted to the central IS unit and (assuming it is approved) take months to implement. Accordingly, local offices opted not to ask their central IS units to adapt their systems to the local requirements (i.e. integrate with PortIC). They use fax or e-mail to fulfill these requirements instead.

5. Action. In February 2005, PortICCO management, given the non-integration of multinationals with PortIC, signed a deal with Inttra (an IOIS for global shipping) in order to integrate both systems. Unlike with CargoSmart where PortIC customers were forced to tightly integrate their systems with PortIC, in the case of Inttra, PortIC customers could get data from Inttra via PortIC through a website or e-mail (both being loose coupling mechanisms). In January 2006, PortIC integrated with Inttra.

6. Primary Consequence. The result has been that some customers of PortIC are making more use of the system to access information from Inttra.

5 Discussion

5.1 Managerial Maneuvers as Mutual Adaptation

The five managerial maneuvers presented above come after the implementation process of the IOIS. The IOIS management acts in order to modify existing (pre)conditions or the consequences of their previous actions to adjust the IOIS to its adopters' environment. Thus the IOIS management performs deliberate actions to resolve misalignments and, in doing so, change the conditions in some way. Those misalignments occur when the structures embedded in the IOIS (e.g. business processes, data models, users' required skills) do not fit in well with the users' environment (e.g. information systems, business processes, practices, users' skills, interests). This is consistent with the mutual adaptation perspective (Leonard-Barton, 1988), which argues that "[technology] implementation is a dynamic process of mutual adaptation between the technology and its [user] environment" (p. 252); and adaptation is needed in reaction to misalignments.

There is some literature (Leonard-Barton, 1988; Soh, et al., 2003; Soh, et al., 2000) that has examined and categorized misalignments in technological implementations. Leonard-Barton (1988) categorizes misalignments in implementations of new technologies as one of three types: technical, delivery system, and value. Soh et al. (2003) adopt a dialectic perspective and show that misalignments that emerge in ERP implementation can be traced to incompatibilities between the structures embedded in the ERP and the structures of the implementing organization; such incompatibilities may be found in: the degree of process integration, the flexibility, the process-orientation, and the domain specificity of the ERP . Soh et al. (2000) classify misfits in ERP implementation into data, functional (or process), and output (or presentation) categories. Relying on these three categorizations we classify the misalignments in IOIS implementations as: technology, functional, people, and value (see Table 2). In addition, as this categorization applies for IOIS, we consider that misalignments

can be located either at the level of the company managing the IOIS, or at the level of adopters.

Table 2: Misalignments

	Company managing the IOIS	Adopters
Technology	Gap between the technical architecture of the IOIS and its original technical specifications.	Gap between the technical architecture of the IOIS and the adopters' technical systems.
Functional	Gap between the data (type and format) and processes supported by the IOIS and the ones defined in the standard.	Gap between the data (type and format) and processes supported by the IOIS (or the standard) and the adopters' data and processes.
People	–	Gap between the skills required to use the IOIS as well as the roles and responsibilities embedded in the IOIS, and the users' roles, responsibilities, skills, and knowledge.
Value	–	Worsening of the adopters' performance as a result of using the IOIS

Table 3 illustrates for the five managerial maneuvers, some of the misalignments and the adaptive responses that were performed in order to adjust the misalignments. Moreover, we observe that adaptive responses acted upon the IOIS or the adopting firms' technological systems, working procedures, human skills, etc., and upon the content of the standard.

Besides the actions shown in the case, managers of PortIC also perform another relevant activity, namely planned user training, which is not explicitly represented in any of the managerial maneuvers but cross all of them. Managers of PortIC want to train end users on how to use the technology in a particular way and thus avoid any surprise; accordingly, the learning of the end users is planned. With such actions managers pretend to address

primarily misalignments between the IOIS and adopters' business processes and skills. On the other hand, however, adopting firms in the study avoided any specific training for their employees –the end users of the IOIS. Managers of these firms considered that end users learned about the new system while using it, namely adaptive or improvised learning. This way of improvised learning was a source of unintended and unanticipated uses (as seen in managerial maneuver 2) for the IOIS management.

Table 3: Managerial maneuvers, misalignments, and adaptive responses

Maneuvers	Misalignments	Adaptive Responses
1. Keeping the autonomy of a adopters	Adopters' functional misalignment: companies wanted to keep their business processes. Thus adapting them to the standard and the new system specifications seemed unnecessary (box 1 and 2); in addition, there was a gap between the specifications of the standard and the current business processes of the adopters (box 2). On the other hand, the initial design logic of the IOIS constrained the use of the system (IOIS functional misalignment in box 6).	The messages and data flows defined in the standard as well as the applications and procedures of the IOIS were adjusted. On the other hand, adopters made some changes to their information systems.
2. Accommodating to unintended uses	IOIS functional misalignment: the web-based application loaded all the fields of a message, when users were only interested in a few of them. That damaged the performance of the IOIS, which in turn penalized the productivity of users in the workplace (value misalignment in box 4). In addition, the architecture of the IOIS had been designed (in terms of hardware and application software) to support a fewer number of transactions (IOIS technology misalignment).	They made changes to the hardware architecture and to the application's logic of the IOIS.

3. Managing the coexistence of multiple exchange channels	People misalignment: in the submission of e-mails to non-adopters, addressees did not receive those e-mails (box 3). This in turn penalized senders work; some of the messages were lost, and this damaged the senders' service to the final customers (value misalignment in box 4). Then senders started duplicating exchange channels, which in turn caused lack of coordination in the message exchanges (Adopters functional misalignment in box 6).	They made changes to the applications of the IOIS and to the working procedures of clerks at the IOIS.
4. Agreeing on the operational use of the system	People misalignment: the lack of homogenization in the use of the system created difficulties to addressee firms when integrating incoming messages (boxes 1 and 2).	Adopters adjusted their exchange systems, working procedures and awareness of the impact of their actions. The IOIS acted as a facilitator in the agreement process by selecting small groups
5. Balancing the degree of integration	Firm's headquarters did not feel it worth integrating their corporate systems with local initiatives such as PortIC because they aim to homogenize their business processes and technologies throughout the corporation not only locally (Adopters technology and functional misalignment).	Adjustments were made to the applications and procedures of the IOIS so that companies could avoid having to tightly integrate their systems with the IOIS. PortICCo provided loose couplings mechanisms.

5.2 Managerial Maneuvers as Opportunity-Based Change

We observe that the IOIS management may become aware of these misalignments when users act to appropriate the system and to adapt it to accomplish their work (for instance, in managerial maneuvers two and three). That is, user actions reveal the existence of misalignments. Those user actions produce changes that were not originally anticipated or intended; namely emergent changes (Orlikowski and Hofman, 1997). When managers of the IOIS identify a misalignment, they may adjust it by reinforcing or correcting the emergent

change that caused it. That is, managers ”develop their deliberative capacities as they confront emergent situations” (Emirbayer and Mische, 1998, p.969). These deliberate actions may be categorized as opportunity-based changes (Orlikowski and Hofman, 1997). That is, these changes were not originally anticipated ahead of time but are purposefully and intentionally introduced during the post-implementation process in response to an unexpected opportunity, event, or breakdown. For instance, in the second managerial maneuver, the use of the web-based application was reinvented by end users, who started using it for more purposes than designers (and the IOIS management) had initially foreseen. In response, managers not only had to upgrade the hardware requirements to accommodate the new pattern of usage that had emerged outside their initial plans, but also redesigned the logic of the application. In this case, although the emergent change was unexpected, it was seen as an opportunity to be reinforced and built on, rather than simply a threat to the plan. In other cases –i.e. the third managerial maneuver– some emergent changes such as the duplication of exchange channels were attenuated; managers acted in order to correct the emergent change, not to reinforce it.

On the other hand, we also observe that misalignments may be disclosed by the users' impossibility or unwillingness to reshape their institutional context: working procedures, routines, organizational structures, coordination mechanisms, etc (for instance in managerial maneuvers one, four, and five). In this case, an intended change (e.g. that adopters introduce changes to systems when integrating with the IOIS) did not occur, and the IOIS management also acted (opportunity-based change) to conform to the emergent situation.

From a managerial perspective unintended and unanticipated uses of the system might not be desirable because such enactments are not predictable and are out of managers' control. However, practice shows that systems integration and use is a process full of surprises that managers cannot control with precision. In the present case, a great number of

the changes and consequences following the implementation of the IOIS were both unintended and unplanned by the IOIS management. In some situations because pre-existing users cognitive frames prevented managers from foreseeing how the IOIS would be enacted, and thus managers could not plan the future uses and consequences of the IOIS. In other situations because the managers did not have time to plan and pretended to learn adopting a trial and error approach. Accordingly, we argue that managers do not have to ignore nor eradicate the unforeseen events; rather they may view and use them as opportunities.

5.3 Emergent Strategies

According to Mintzberg (1994), strategy may be not only plan but also pattern; that is, "organizations develop plans for the future and they also evolve patterns out of their past [actions]" (p.24). Mintzberg distinguishes "between deliberate strategies, where intentions that existed previously were realized, from emergent strategies, where patterns developed in the absence of intentions, or despite of them (which went unrealized)" (Mintzberg, et al., 2003, p.16). A realized pattern that was not "expressly intended" but emerges is called an emergent strategy, which is defined as a set of "actions…taken, one by one, which converged in time in some sort of consistency or pattern" (Mintzberg, 1994, p.25). Emergent strategies are not explicitly formulated by managers. Rather managers deal with events and opportunities on an ad hoc basis following a pattern.

We observe (see Table 4) that the five managerial maneuvers converge into two emergent strategies. These strategies come up as the IOIS managers carried out a series of actions that with time have turned into a consistent pattern of action. These emergent strategies are: 1) attract users to bootstrap the IOIS, and 2) keep the IOIS adaptable. These two emergent strategies are consistent with the two design strategies for information infrastructures proposed by Hanseth and Lyytinen's (2006): bootstrap installed base, and avoid technology lock-ins.

In our case, both strategies seek to grow the installed base of users, and to increase the use of the IOIS. In the first strategy, the IOIS management acts in order to bootstrap a minimum community of users and from that point the IOIS will grow. Managers attract users by recognizing their pre-existing information systems, practices, rules, working procedures, etc. On the other hand, in the second strategy, the IOIS management tries to keep the IOIS adaptable and flexible in order to grow –for instance, to enable the interoperability with other IOISs– and not to get trapped by changes in technology, new requirements from adopters, etc. From the case study we observe that the second strategy is subordinated to the first one. That is, managers by keeping the IOIS adaptable are also able to attract more users; the second strategy reinforces the first strategy. Moreover, from the case we observe that there are managerial maneuvers –second, third, and fifth– that fit into both strategies. For instance, with the fifth managerial maneuver, IOIS management, on one hand, wanted to attract new users, especially big companies that were already integrated with other IOIS; on the other hand, by interconnecting PortIC with other IOIS the IOIS management wanted to give more value to existing adopters, and consequently, increase the extent of use of the IOIS.

Table 4: Relation of Maneuvers with Emergent Strategies

	Emergent Strategies	
Maneuvers	**Attract users to bootstrap the IOIS**	**Keep the IOIS adaptable**
1. Keeping the autonomy of a adopters	✔	
2. Accommodating to unintended uses	✔	✔
3. Managing the coexistence of multiple exchange channels	✔	✔
4. Agreeing on the operational use of the system	✔	

5. Balancing the degree of integration	✔	✔

In short, we consider that in the management of IOISs coexist two modes of operation. One characterized by intended formal planning, in which the implementation goes according to plan and use follows as expected, and another characterized by maneuvers triggered by local reinventions, adaptations and drift. In the second approach, the object of study in this paper, the IOIS emerges from users' enactment and reinforcement of the system, which managers has difficulties in foreseeing and cannot avoid, and the managerial responses to accommodate unforeseen events. The users' interventions as well as the adaptive responses that managers perform may be interpreted as maneuvers. That is, they are short-tem, rapidly moving, dictated by and forcing the seizing of the moment. In contrast to formal, straight, stable and rigid interventions embedded in methods and plans, maneuvers are contingent actions that are meaningless outside the specific situation (Mintzberg, 1994). They are needed to fill the gaps of formal planning and to cope with unintended consequences.

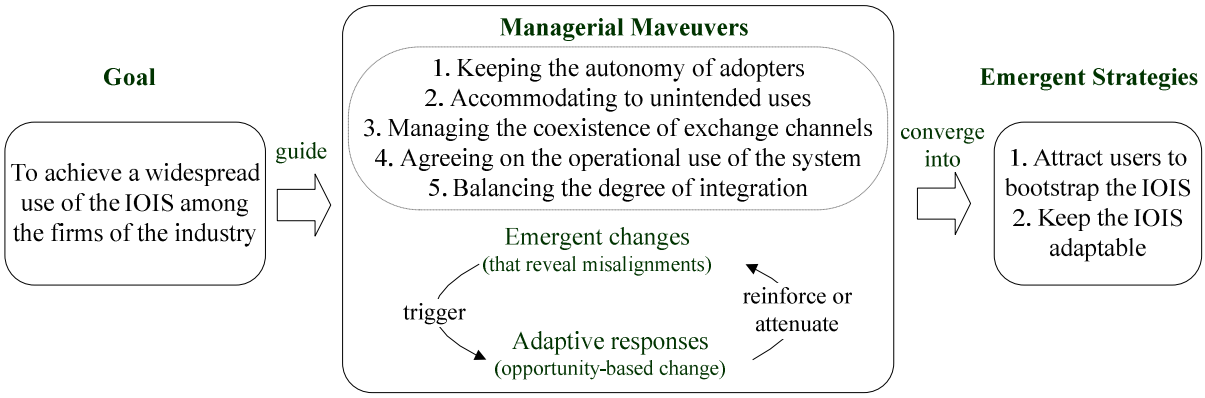
6 Conclusions and Contributions

In this paper we have taken a process view informed by mutual adaptation, organizational change and emergent strategy literature to study the management of an industry IOIS. Such a perspective helps us focus on the managerial actions following the implementation process of an IOIS, and show that the strategies towards an increase on the use of the IOIS applied by the IOIS management in our case study are emergent rather than deliberate.

As it is shown in Figure 1, we argue that a relevant goal for the IOIS management, in the post-implementation stages, is to achieve a widespread use of the IOIS among the firms of the industry. This goal affects and guides managers' decisions and actions. In the daily

operation of the IOIS, managers have to deal with emergent changes (Orlikowski and Hofman, 1997) –i.e. unexpected user appropriations of the system. Such emergent changes create unforeseen conditions and reveal misalignments (Leonard-Barton, 1988), which trigger managers to perform adaptive responses (opportunity-based changes) in order to reinforce or attenuate them; in turn, as managers respond, new unintended outcomes and changes may emerge. We have grouped the adaptive responses that arise from the case into five managerial maneuvers: keeping the autonomy of adopters, accommodating to unintended uses, managing the coexistence of exchange channels, agreeing on the operational use of the system, and balancing the degree of integration. Finally, we observe that these maneuvers converge into two strategies in action, also referred as emergent strategies (Mintzberg, 1994): attract users to bootstrap the IOIS, and keep the IOIS adaptable. These two emergent strategies seek to grow the installed base of uses and the use of the IOIS.

Figure 1: Model for Managing the Post-Implementation of IOISs



We believe this paper contributes to research. First, prior inter-organizational information systems (IOIS) literature has proposed primarily factor-based models to explain either the adoption decision (Iacovou, et al., 1995) or the extent to which the IOIS is used (Massetti and Zmud, 1996). Although these studies can support managers in their daily practice, our paper complements them by adopting a processual perspective and reporting on the intricacies that arise during the implementation and post-implementation. Secondly, we

use grounded theory, which to our extent has not already been used in the process-oriented IOIS literature. Thirdly, the paper illustrates the use action-oriented diagrams; we believe such diagrams are useful graphical tools that help structure and report on processual data, which constitutes an important task during theory modeling. Finally, the five managerial maneuvers and the emergent strategies that arise from the case add external validity to Hanseth and Lyytinen's (2006) design theory for information infrastructures.

We believe this paper also contributes to management. First, we show that given the role of unintended uses and change, IOIS implementation requires management: 1) not only to place emphasis and devote resources to design, predict future conditions, and develop strategies and actions to meet those predictions, but also to pay attention and understand the unexpected events and emergent changes that arise during use of the IOIS; and 2) to respond in order to reinforce or attenuate the emergent changes. Secondly, we show that although managers may formally articulate strategies on a periodic basis (formally planned strategy), enhancing the use of the IOIS lies in their ability to anticipate surprises, watch for them, and encourage small emergent and opportunity-based changes. As Emirbayer and Mische (1998) state "if we cannot control de consequences of interventions, we can at least commit ourselves to a response, experimental, and deliberate attitude as we confront emergent problems and possibilities across the variety of context within which we act." (p.1013). That is, the IOIS management cannot only be conceived as pre-defined planned intervention, but also as a form of reaction and response to situational demands and others' –i.e. users– behavior. Finally, we have presented a set of managerial maneuvers that converge into two emergent strategies –attract users to bootstrap the IOIS, and keep the IOIS adaptable–, which have been effective in fostering the integration and use of an IOIS. Although our findings lack generalizability, we think these managerial maneuvers may serve as a helpful guide to

action for IOIS management. Thus this paper has pragmatic legitimacy as it contributes to the creation of how-tos with practical value for the IOIS management.

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Appendix 6

Christiaanse, E., and Rodon, J. (2005) "A Multilevel Analysis of eHub Adoption and Consequences", *Electronic Markets*, 15 (4):355-364.

A Multilevel Analysis of eHub Adoption and Consequences

ELLEN CHRISTIAANSE AND JUAN RODON

A b s t r a c t

Although there has been a significant amount of research on the adoption of IS standards and consequences, most has tended to focus on traditional EDI standards, paying special attention to factors of individual adopters. However, the current proliferation of new IS standards, based on open technologies, increases the potential for interorganizational collaboration. Research, therefore, needs to raise the level of analysis to that of the constellations of organizations that are part of the industry network. This contribution examines how the structural properties of the network impact on the adoption decision and how the adoption in turn produces changes in the structure of the network. Furthermore, we advocate a multilevel analysis of the consequences of using IS standards and eHubs. We explore and illustrate our theoretical arguments with a case study on the adoption and use of an IS standard and eHub in the chemical industry.

Keywords: IS, industry standards, electronic hub, adoption, network

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INTRODUCTION

The emergence of open technologies like XML has resulted in new opportunities for conducting B2B transactions. Nevertheless, the real benefit from the use of these open technologies must come from the integration of intercompany processes and applications (Markus *et al.* 2002). A prerequisite for this inter-firm integration and interoperability is the existence, particularly at the industry level, of IS standards (Markus *et al.* 2003, OECD 1996) that define how organizations within that industry can carry out their transactions electronically.

The adoption of these IS industry standards is taking place in networks of organizations, thereby levering firms' network resources. The importance of a firm's internal resources is widely accepted in the strategy literature in general (Barney 1991) and the competitive dynamics literature in particular (Chen 1996; Grimm and Smith 1997). Following Gnyawali and Madahavan (2001), we consolidate four sets of arguments to establish that resources also reside in the firm's external network and are important to a firm. First, relationships in a network are potential conduits to internal resources held by connected actors (Nohria 1992). Second, external economies, i.e., 'capabilities created within a network of competing and cooperating firms', often complement the internal resources of the firms involved (Langlois 1992). Third, the rate of return on internal resources is determined by how well structured the firm's network is (Burt 1992) and fourth, a firm's position in a network contributes to its acquisition of new competitive capabilities (McEvily and Zaheer, 1999), which, in turn, enhances its ability to attract new ties (Powell *et al.* 1996). We argue that IS standardization initiatives in vertical industries lever network resources impacting on the adoption of the standard and resulting benefits.

Literature supports the existence of standards as an antecedent to the adoption of electronic intermediaries (Chwelos *et al.* 2001; O'Callaghan *et al.* 1992). However, those studies focus on EDI standards, which were proprietary and supported dyadic relations, paying special attention to the organizational level and not allowing for the complexity of networks with more than two nodes. New IS industry standards (i.e., CIDX, MISMO) as well as electronic intermediaries like eHubs, make real-time information exchanges easier and emphasize exchanges at the interorganizational level. A first argument here is that the study of IS

industry standards and eHubs adoption should examine the network structure of industries.

On the other hand the economics literature, focusing on the diffusion and outcomes of network technologies, has shown that there is a positive correlation between the number of firms adopting the standard and its utility (Katz and Shapiro 1985). Other research has investigated the consequences for firms of the use of standards (Mukopadhyay and Kekre 2002). Some of these consequences, however, affect the constellations of organizations and network levels (Christiaanse 2005). The deployment and use of IS industry standards and eHubs is expected to improve information flows among partners and to reduce coordination misalignments across the supply chain (Gosain *et al.* 2003). A second and related argument here is that the use of eHubs in vertical industries creates some collective benefits that go beyond the organizational or dyadic levels.

This contribution addresses the following research questions: (1) Do industry network properties affect eHub adoption, and how are they affected? and (2) What collective benefits arise from the use of eHubs? To answer these questions, we develop a theoretical model and present a case study of an eHub in the chemical industry that illustrates our theoretical arguments.

The structure of the paper is as follows: The literature review on IS industry standards and eHub adoption and its consequences on network structure is presented in the following section. We then introduce a case study from the chemical industry, which illustrates our main arguments. The final section presents our conclusions and some guidelines for future research.

THEORETICAL ANCHORING

IS industry standards and eHubs

The development of electronic intermediaries to conduct B2B electronically entails first choreographing cross-company business processes and having common data definitions to create the IS industry standard (Rodon *et al.* 2004). Once the standard has been developed, firms need to develop the technological infrastructure that will support the standard. They may then choose between several alternatives: 1) implementing customized one-to-one integration with partners, or 2) using an electronic intermediary to interact with trading partners (Markus *et al.* 2002). Within the electronic intermediary alternative we may find: 1) private exchanges developed by a powerful player in the industry (e.g., MyAccount@Dow from Dow Chemical, BayerONE from Bayer); 2) independent exchanges, which are developed by third parties that do not belong to the industry but mediate trading for an industry; or 3) consortia exchanges, or eHubs, in which some firms in an industry support a common technology infrastructure for trading (Damsgaard and Lyytinen 2001). Several examples in different industries (Christiaanse and Damsgaard 2000; Forster and King 1995; Markus *et al.* 2003; van Baalen *et al.* 2000) show that results of standard setting efforts are mixed.

We define eHubs as shared and heterogeneous IT infrastructures that act as intermediaries underpinning interfirm relationships and embedding a set of business rules defined by the IS industry standard. eHubs are shared in the sense that they are usually set up, owned and used by firms in the same industry that create a consortium. In these consortia, standards and eHubs emerge through the cooperation of various actors, who simultaneously cooperate to increase the efficiency of the whole industry and who compete for the same customers (de Vries 1999). eHubs are heterogeneous in two senses. First, they encompass multiple technological artefacts as well as non-technological elements (social, organizational, institutional, etc.) that are necessary to sustain and operate the eHub (Kambil and van Heck 2002). Second, eHubs implement multiple versions of the same standard, or embed several standards for the same functionality (Hanseth and Lyytinen 2004).

Adoption and network structure

Research on antecedents to electronic intermediaries adoption has used diffusion of innovations theory (Rogers 1995) to identify factors that predict the adoption (see (Ramanathan and Rose (2003) for a review). These factors span three levels: organization (IT sophistication, financial resources, trading partners' readiness), environment (competitive pressure, dependency on trading partners, industry pressure, enacted trading-partner power) and technology (perceived benefits of the electronic intermediary) (Chwelos *et al.* 2001; Iacovou *et al.* 1995; Premkumar and Ramamurthy 1995).

This paper explores more deeply the impact of the external environment on the adoption by focusing on the industry-level embeddedness. In the context of vertical industries, actions by firms – the decision to adopt a standard or an eHub – may be affected by the network of relationships in which they are embedded (Granovetter 1985). This embeddedness perspective has, to our knowledge, not been included before in the study of standards and eHub adoption. In our view, four elements explain the relevance of the embeddedness perspective to the study of eHub adoption. First, adopters belong to the same industry and, therefore, they do not act in a vacuum, their actions being embedded into the existing network of relationships. Second, the whole industry network has a common interest in a wide adoption of the eHub. Third, firms involved in the adoption know each other and trade with each other, thereby enforcing the concept of

embeddedness. Finally, eHubs have the capability to bind competing and cooperating firms together.

To explore the relationship between the network structure and eHub adoption we will use properties at different levels. The reasons for advocating multilevel analysis are:

1. Just as with EDI, eHub adoption dynamics is a multilayered phenomenon involving organizational, industrial and institutional levels (Damsgaard 1996);
2. Literature on embeddedness has focused on the firm and network levels (Granovetter 1985); and
3. Different properties of the network have different effects on the flow of resources.

As actors want to optimize these flows, attention has to be paid to the network properties (Gnyawali and Madhavan 2001). We use three structural properties of an industry network (Figure 1): centrality, structural equivalence and density.

The influence of network structure on adoption. *Centrality* is a firm-level measure that reflects the extent to which a focal actor occupies a strategic position in the network by virtue of being involved in many significant ties. Centrality can be measured by degree (number of direct links with other firms), or by closeness (extent to which an actor is close to or can easily reach all other members in the network) (Monge and Contractor 2003). High centrality will lead to a higher volume and speed of asset, information and status flows, and generally, central firms will benefit from a positive resource asymmetry (Gnyawali and Madhavan 2001). In the context of industry networks, central actors will have greater access to external resources than non-central ones (Gnyawali and Madhavan 2001), will perceive the cost benefits that may arise from standardizing the exchanges with partners in the network and will have higher power to influence the adoption of the eHub within the network. This last point fits in with the literature on adoption, which recognizes the power – coercive or support strategy – exercised by the initiator of an EDI link (Premkumar and Ramamurthy 1995). Therefore, we argue that a central firm will be the most interested in adopting and promoting the eHub adoption.

Structural equivalence is a 'pair-level measure of how similar the actors' network patterns are – the greater the similarity in the actors' network, the greater structural equivalence of these actors' (Gnyawali and Madhavan 2001: 437). Structurally equivalent firms, although not necessarily connected, can be viewed as having similar asset, information and status flows and somehow being symmetrical in their resource profiles (Gnyawali and Madhavan 2001). In the context of industry networks, structurally equivalent firms, especially central firms, will perceive that they will benefit more from standardizing their similar interaction patterns and will therefore combine their efforts to promote the adoption of the eHub.

Density is a network-level measure that refers to the degree of interconnectedness or the number of actual links to the number of possible links in the network (Monge and Contractor 2003). A dense network, meaning a network in which the members have no redundant ties: (1) increases the flow, access and sharing of information; (2) functions as a closed system, and so trust, shared norms and common behavior are developed more easily; and (3) facilitates monitoring and effective sanctioning, making it less risky for members in the network to trust each other (Gnyawali and Madhavan 2001). In dense networks, because of the high interconnectedness, firms clearly perceive the benefits of standardizing interactions, and they will therefore be more willing to adopt an eHub. However, because of the promotional effort that central firms may carry out, it is expected that dense networks without clear central firms will have more difficulties than dense network with central firms.

The influence of adoption on network structure. Literature on the impact of IT on networks or supply chains has assumed that IT deals with the collection, processing and diffusion of information across the network, and has focused on the changes in information flows. Nevertheless, information can be seen as a representation of other network resources – assets and status. IT may therefore have a direct effect on information and an indirect effect on the other resources. We consider that the adoption of eHubs within an industry network will have direct effects on the flows of information between the firms in terms of accessibility, speed, frequency and volume. For instance, the eHub might filter unwanted information or forward some kind of information to network partners that they

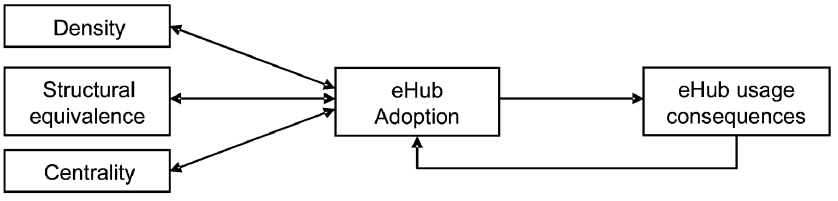

Figure 1. Industry network properties, eHub adoption and usage consequences

might not otherwise get. These changes in the flow of information may have an effect on assets and status flows, thereby producing changes on the structural properties of relationships (Figure 1). For example, adopting an eHub may lead to a standardization of the interaction patterns in the industry network and may consequently increase firms' structural equivalence. Central actors who are able to integrate their systems with the eHub may enjoy some information benefits, leading to more power and thus increasing their centrality; or, as the number of adopters of the eHub grow, a self-reinforcing process of adoption may start (Hanseth and Lyytinen 2004), which may result in an increase of the number of links of the network.

Consequences of eHub use

The economics literature has shown that the size of the network adopter and the resulting network externalities will determine the value of the electronic intermediary (Katz and Shapiro 1985). Other research has used the industrial organization literature to analyse the adoption of EDI systems as a means of achieving a competitive advantage (Barua and Lee 1997). This literature views the adoption as a way to increase transaction efficiency by reducing coordination costs and increasing the coordination and control capabilities of individual firms (Malone *et al.* 1987). From a transaction cost perspective, the development of electronic intermediaries based on open technology standards (i.e., XML, web services) is also expected to decrease asset-specific investments for firms that adopt them (Christiaanse *et al.* 2004). Apart from this asset-specificity argument, this stream of research assumes that the benefits from IT use come from streamlined flows of information. However, effects of usage could also be measured in terms of effects on resources, not only representations of resources, as is the case with information. By filling this gap, the resource-based view of the firm has been used to analyse the impact of IT on organizational performance (Bharadwaj 2000) and to understand how trading-partner resources affect the ability to generate IT business value (Melville *et al.* 2004).

Other research on the consequences of IS industry standards and electronic intermediary usage has classified the benefits from their use into direct, first-order, operational and indirect, second-order and strategic (Iacovou *et al.* 1995; Mukopadhyay and Kekre 2002; van Baalen *et al.* 2000). The first type of benefit which usually deals with automation of daily processes and cost reduction, whereas the second type of benefit, which accrue over an extended period of time, is associated with improved partner relations (i.e., customer, supplier, etc.), increased flexibility and responsiveness (Mukopadhyay and Kekre 2002; van Baalen *et al.* 2000). Furthermore, the second type of benefit cannot always be captured unilaterally by one of the firms, or may be captured by the constellations of organizations that are part of the industry network. In the case of IT that spans firms' boundaries as with eHubs, business processes, IT resources and other trading partner resources play a role in the final impact (Mukopadhyay and Kekre 2002). For instance, firms with deeply embedded EDI are supposed to gain more strategic benefits than those with a lesser level of embeddedness (Chatfield and Yetton 2000). Christiaanse (2005) states that research on the consequences of eHub adoption should be orientated towards the network level instead of the dyad or organizational levels. In line with this statement, Straub *et al.* (2004) develop the network organizational construct, which they define as the aggregated performance of partners in the supply network. Here, we advocate the need for a multilevel exploration of the benefits (organizational, dyadic and network) that arise from the deployment and use of IS industry standards and eHubs. This is relevant, as the level of competition is increasingly moving from the organization to that of the network and integrated business networks compete against other networks (Vervest *et al.* 2005).

Our conceptualization of eHub adoption as influenced by structural embeddedness provides a new perspective to the research on antecedents and consequences of adoption (Figure 1). This paper complements previous research in three ways: First, through our focus on the impact of the network structure on the adoption decision. Second, by focusing on the changes in the flow of resources and the network structure, as a result of adopting an eHub. Third, since IS industry standards and eHubs embed the interorganizational practices, the analysis of the consequences of using eHubs requires not only focusing on the firm level, but also examining the existing network of relationships. We will now illustrate these arguments with a case study of an eHub in the chemical industry.

Research method

The case material was compiled over a four-year period (2001–5). The data were gathered through 28 in-depth interviews with members of the chemical industry (i.e., Elemica, Dow, Bayer, BASF, Shell, DSM). The interviewees were managers of the participating companies and their clients in addition to interviews with the computer technicians involved. Interviews lasted between one and a half hours and three hours, were semi-structured and dealt with questions on the importance of standardization in the chemical industry, the adoption decision to join Elemica, its implementation process and its impact both on the firm and on the industry as a whole. All interviews were recorded and transcribed. In addition, we attended Elemica world

conferences, where we talked to 20–30 additional Elemica customers and held short 15-minute interviews with stakeholders. Internal documents from these companies, teaching cases and press articles were also gathered and analysed. Earlier casework was reported in (Christiaanse 2005; Christiaanse and Markus 2003; Christiaanse *et al.* 2003; van de Ridder 2004). The next section will describe the case study and its context – the chemical industry.

CASE STUDY

IS standards in the chemical industry

The chemical industry is characterized by being fragmented (more than 76,000 companies worldwide and the top ten global companies' sales represent about 20% of the total), working largely with pre-negotiated contracts (between 80% and 90%) and conducting a considerable amount of intra-industry trading (around 50% of industry's output is purchased by itself) (Christiaanse 2005; Liveris 2002).

The CIDX (Chemical Industry Data Exchange) is a standards development body in the chemical industry that has focused on improving the ease, speed and cost effectiveness of electronic business transactions among chemical companies and their trading partners. Three principles guide the development of CIDX standards: open (available free of charge to members), neutral (to support current and emerging business models) and platform independent (to prevent restricting the use of any hardware or software platform).

CIDX is in charge of Chem eStandards™, a set of global open XML-based data exchange standards applicable throughout the online chemicals trading network: manufacturers, distributors, logistics providers, financial institutions, electronic marketplaces and other industry consortia. Chem eStandards™ is the result of an effort initiated by BASF, Dow and DuPont in July 2000. Chem eStandards™ covers message formats and business process scenarios; it defines 60 business transactions and encompasses company-to-company, company-to-eHub, and eHub-to-eHub e-commerce activities.

ELEMICA CASE DESCRIPTION

On 17 May 2000, 22 major chemical companies founded Elemica. 'The idea behind Elemica –a cooperative alliance between competitors – is to create a chemical industry network linking individual information systems and aiming to reduce supply chain inefficiencies, and to strengthen buyer–supplier relationships, those where contracts are in place' (Elemica 2005). Elemica does not present itself as an electronic marketplace in the sense of a trading platform that openly displays offers or requirements, but as a neutral eHub for the exchange of documents focused on the chemical industry to help members execute their relationships more efficiently. As one of the interviewees from BASF explained:

> *the idea behind is really to standardize. And we as BASF, we are with DOW the biggest chemical company in the world, we see the way is to standardize internally and externally. This idea is very good and we have found support very quickly. This was the basic idea when we started it. We supported Elemica with many people from the industry.*

Elemica integrates its systems with participating companies' ERP systems, and supports Chem eStandards™, but does not require chemical companies to comply with Chem eStandards™. Instead, Elemica uses a hub-and-spoke model in which a message coming from one company, in any format, is translated into Chem eStandards™, and finally if necessary into the recipient's format. According to Stewart McCutcheon, Elemica's CTO, (ChemWeek 2002):

> *the key to Elemica Connected Solution is interoperability. We ensure that the various protocols (Chem eStandards, xCBL, EDI and SAP IDOCS), business processes and data standards work together.*

For companies that do not have ERP systems in place, Elemica offers web-browser access (i.e., the Buyer Direct solution). By so doing Elemica allows chemical companies to communicate seamlessly with regard to their use of the IS industry standard. An interviewee from Bayer illustrated:

> *internally we had to change the way we do business. Not from better to worse, but you have to change it. And we have to explain to people: 'Please, from now on, do this first and not that. Because this is the way Elemica does business and this is the way we standardize it.'*

The goal of this analysis is threefold: First, we show how the structural properties of the industry network (centrality, structural equivalence and density) influence the adoption decision. Second, we want to demonstrate that the adoption of Elemica creates changes to the structure of the network. Third, we conduct a multilevel analysis of the benefits derived from adopting and using Elemica.

The impact of network properties on adoption

Central firms in the chemical industry are more likely to consider CIDX as important and to perceive the benefits, in the form of positive resource asymmetries, of adopting Chem eStandards™ than other non-central

actors in the industry (eyeforchem 2003b). Citing one of the interviewees from one of Elemica's central initial investors:

> *We were looking for the value in a detailed way. One of the promises of Elemica is that they will reduce the costs per order (of order treatment). We had an internal project going on to compare the cost of order process within our different sites in Europe and we expanded this project to Elemica, treating Elemica as a site. Now we can also prove that Elemica is also offering us real value. If Elemica is running it costs less to treat one order than without Elemica.*

On the other hand, partners of those central firms, usually small and medium-sized enterprises (SMEs), do not perceive adopting Chem eStandards™ as so important, because: (1) they have less volume of document exchange; (2) they depend on the dominant partners' actions; (3) the practices reflected in IS industry standards fit better with those of dominant firms that have previously participated in the standard development committee (CIDX); and (4) they sometimes cannot afford the investment required to implement the technological infrastructure. An interviewee from an SME observed:

> *We use some VMI stuff, but it is not widespread. The problem is that until you really do a significant amount in terms of kilos of materials, it is just a cost. That is why, unless we have to do this, we will not work hard in trying to push it. So we only do it when it becomes a business requirement.*

One the other hand, a representative from Bayer commented on this firm's relationship with small firms:

> *In the coatings business we have a number of companies, smaller sized and medium sized, that we have business relationships with that we talk with about Elemica. And many of these companies, even if they are small, do a fair amount of their business with people that are on the Elemica network. We are talking with coatings customers, with distributors, who are also a group of companies that is likely to have many business relationships within the chemical industry. The smaller companies also have the means to connect. Maybe a full connection if they are able to and willing to, but also to connect with us on the basis of a web-based solution. So the size for us is not a criterion, it's the amount of business we do with them and they will do with the entire Elemica network.*

Elemica, as well as Chem eStandards™, was initially promoted by a group of structurally equivalent firms (Dow Chemical, BASF, DuPont) in the industry, who cooperated because they did not want to put themselves in the hands of a third party that wedged between themselves and their customers, which could have controlled the relationship and captured its value by controlling resource flows (Liveris 2002).

The impact of adoption on network properties

Regarding changes in flows of resources, we observe that Elemica speeds up asset flows (through electronic payment delivery times may be adjusted), and influences the flow of status (we observe that SMEs that line up with Dow Chemical will gain recognition and legitimacy by Dow and other large chemical firms).

Within the Elemica network, some members, usually central actors, might enjoy positive resource asymmetries. For instance, Dow Chemical and BASF might benefit more from ERP-to-ERP connectivity than SMEs who do not have ERP and have opted for a web-browser access. The higher centrality and integration, through ERP-to-ERP connectivity, that some of the members in the Elemica network have reached allows them to improve the flow of assets (lower inventory, higher reliability of raw material availability) and information flows (automatic order response, status messages, inventory management and control), thus somewhat strengthening their centrality.

In addition the adoption of Elemica influences the density of the network by:

1. Facilitating the flow of information among chemical companies. Bill Edwards, from Foamex International Inc, observes (Shell 2004): 'Elemica gives us the opportunity to connect with a larger number of suppliers across a number of chemical product categories. It means we have the same level of automation of order and information exchange each time, and don't have to make new connections with every new vendor.'
2. Providing visibility to the supply chain processes and therefore easing monitoring. Mike McGuigan from BP's Petrochemicals Business notes (eyeforchem 2003a): '[Using Elemica TransLink] not only gives us the capability to connect to our carrier base via B2B or web links, but will allow us to build this foundation to provide greater visibility into our supply chain for both BP's organization and our customers.'
3. Strengthening existing ties and developing trust between partners. In the words of one interviewee talking about the adoption of Elemica to interact with a customer: 'you analysed the business process from a demand chain perspective …you went deep in the relationship and say: ''Okay, what is it exactly what we are doing? Why are you keeping safety stocks and why am I doing that too? Shouldn't we start trusting each other? Shouldn't we eliminate part of that stock? Shall I keep stocking and you not? Should we do VMI?'' So you end up with a deeper relationship. Especially if you go to VMI [Vendor-Managed Inventory], then there is an enormous trust, because that means that you are a single supplier. You have this tank or this warehouse

and so, you are the only one that supplies this product and the customers are totally relying on you to make sure that the product is always there.'

4. Increasing the flow of information between chemical companies and others outside the industry (carriers, storage facilities, freight forwarders, contract manufacturers, customs agents, telemetry providers) through hub-to-hub connections. Udo Lindeman, from Bayer Rubber Business Group, comments on the hub-to-hub connection between Elemica and RubberNetwork: ' the alliance between Elemica and RubberNetwork will enable Bayer to link our supply chain with supply chains of multiple customers in the tyre and rubber industry through one industry connection.'

At the industry level, due to the hub-to-hub connections, the Elemica network is expected to gain more centrality in the industry. This higher centrality could result in an increase of Elemica attractiveness for chemical companies and companies from other industries that have business relations with the chemical industry. This would lead to a growth of critical mass (adopters of Elemica) and the resulting network externalities will then determine the value of Elemica and ensure its survival.

Consequences of eHub use

Next we present the benefits of deploying and using an eHub at the organizational, dyadic and network levels. In addition, we present other consequences of the application and use of eHubs in the chemical industry.

Organizational

At the organizational level we have found two groups of benefits in this case: cost and scale, and internal integration. First, as a result of an increase in information flows, firms can now work with lower inventory (Backhaus 2004). Second, Elemica offers the capability to quickly establish an interorganizational tie within the chemical industry, and cuts down the technological and the syntactical, semantic and pragmatic interconnectivity barriers. Elemica provides tiered integration, which cuts connectivity costs and enables the Elemica network to scale across SMEs. Each network member only needs to incur the cost of connecting to the eHub once, rather than sustaining different links for every partner in the network. By allowing firms to connect only once to interact with other partners in the industry and by connecting to other industries' eHubs, Elemica could become a ubiquitous platform for the chemical industry.

Finally, when an organization is structurally complex and geographically dispersed, implementing an ERP system to achieve internal integration is sometimes a tough task (Markus *et al.* 2000). In such cases, eHubs could become a solution for internal integration. Debra Marshall from Shell Chemical observes (Shell 2004): 'The cost of globalizing and standardizing an ERP system can be prohibitively expensive. In these cases Elemica can be used not only to exchange data with trading partners but also to interconnect business units that may be operating incompatible business processes.'

Dyad. First, at the dyadic level Elemica offers optimization of interfirm processes. eHub adoption has led firms to focus not only on improving internal processes but also on streamlining interfirm processes. An interviewee observed:

> *The B2B connection with Shell Chemicals Europe [through Elemica] has enabled us to automate a lot of these repetitive routine tasks ...It's real-time processing, which has made the order creation, processing and completion much faster – now things happen in a matter of seconds. It means our operational supply chain can now focus on exception handling rather than performing the same transaction over and over again.*

Second, Elemica does not try to bridge the existing structural holes (Burt 1992) in the chemical industry (as do other electronic intermediaries like ChemConnect) but tries to give support to existing long-term and stable buyer–supplier relationships. Elemica increases the speed and volume of information flows and reinforces existing ties, improving the chance for information sharing and collaboration. As one interviewee observed:

> *The customer says: 'This is my inventory and this is my demand forecast.' Based on this message we, as a supplier, can act in order to make sure their stock level is maintained at the right level. These types of messages are being exchanged through Elemica.*

Network. A first example of a network benefit that an eHub can provide can be found in electronic invoicing and payment. Just seeing an electronic invoice versus paper as a cost reduction for firms is not a great gain. As Kent Dolby, CEO of Elemica, observes:

> *Today, when the companies buy and sell from each other, they then go through an invoice process and there is a payment process. And the payment process may include some review of receipts and some review of either electronic or paper documents, and eventually settlement invoices, cash is transferred. What I see in the future is the ability for Elemica to serve as a clearing house ...where we would actually do cash netting at*

the end of the day ...There are no payment terms. There is no delay in the payment process, it is fully automated.

Second, eHubs may provide cross-industry interconnection. For instance, Elemica offers chemical companies hosted supply-chain management applications aimed at collaboration (i.e., VMI and CPFR). The companies using these hosted applications have experienced cost reductions in connecting and licensing the software as well as reductions in inventory and greater efficiency in logistics management (Metcalfe *et al.* 2004). In 2003, Elemica acquired Optimum Logistics, a global marine logistics solution for the chemical industry, and started offering the TransLink application as a hosted application. As a result, chemical firms could avoid the costs of licensing and implementing the application. Furthermore, Elemica was able to interconnect its customers' ERP systems with TransLink, thereby integrating logistics process and data and increasing the visibility of information and the agility of asset flows that extend beyond the chemical industry.

eHubs enhancement of IS industry standard adoption. The effort to develop and implement an eHub may be seen as a process of standardization. We can interpret Elemica's implementation process as a twofold process of standardization: 1) Elemica is based on Chem standards; and 2) the implementation process of Elemica constitutes a standardization process among members of the chemical industry.

eHubs like Elemica facilitate the use of IS industry standards by requiring companies to maintain only one connection to the eHub, and the eHub making the translation of messages into the IS industry standard (Chem eStandards^{TM}). As one interviewee observes, even when firms comply with Chem eStandards^{TM} there are incompatibilities:

In spite of the widespread adoption of the Chem eStandard, different versions of these standards are being used, because every organization adopts a new version and at another speed. This is where Elemica offers their translation service to translate to the different versions.

This also confirms the observation that IS industry standards like Chem eStandards^{TM} are enacted in their use, and that they should be used as a frame of reference (Damsgaard and Truex 2000). This is due to: 1) the cost firms have to incur in developing an IT infrastructure that supports an IS industry standard; 2) the complexities in coordinating bilateral relations with partners or upgrading to new versions of standards; and 3) the nature of supply chains which cross several industries (in our case chemical, transport, rubber, automotive), sometimes each having their own IS industry standards.

Impact on software industry. Finally, the pressure towards software application providers (i.e., SAP and Manugistics) to adhere to the Chem eStandards^{TM} is increasing, with Elemica being the industry platform for electronic messaging. Penalties for non-compliance with Chem eStandards^{TM} and with Elemica may be high, because chemical firms will prefer to implement software applications that allow them to seamlessly interact with industry partners.

CONCLUSIONS

This paper contributes to the existing literature on interorganizational systems adoption by raising the level of analysis to that of the network. We call for an exploration of the embeddedness perspective in the research of eHub adoption and its consequences by developing three arguments. First, we considered the structure of an industry network –centrality, structural equivalence and density – as affecting the adoption decision. At the organizational level, central firms are expected to adopt and foster the adoption of eHubs. At the dyadic level, structurally equivalent firms, especially when central, will perceive the standardization of their similar interaction patterns as beneficial and will therefore be more willing to adopt an eHub. At the network level, because of the benefits of standardizing interfirm exchanges, firms in dense networks will be more prone to adopt an eHub. Second, the adoption of an eHub within an industry network may have a direct effect on the flow of network resources – information, assets and status – and these effects, in turn, will produce changes in the structural properties of the network. Similarly, Markus *et al.* (2003) state that the proliferation of IS industry standards and eHubs is not only changing industries' working practices, but also their structure. Our final argument is that the adoption and subsequent use of eHubs may create collective benefits for the industry that go beyond the organizational and dyadic levels. We have illustrated these theoretical arguments with a case study of an eHub called Elemica in the chemical industry.

We note several limitations of our embeddedness approach. First, we have used three properties of industry networks, but have not attributed importance to them. Depending on the type of industry, these properties may exert different influences in the adoption decision. Second, examining how the adoption changes the structure of the industry entails doing process analysis, and thus data must be collected using multiple timeframes. Similarly, examining collective benefits requires collecting diverse and complex data.

We expect that more varied forms of IS industry standards and eHubs will emerge in the near future. Research needs to continue in order to understand how the structure of the different constellations of firms that

constitute an industry network shape the adoption of IS industry standards and how these structures evolve. Future research should also examine and measure the value that these constellations of firms get from adopting an eHub.

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