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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

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. Problem-atization 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 ir-reversible 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

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[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-

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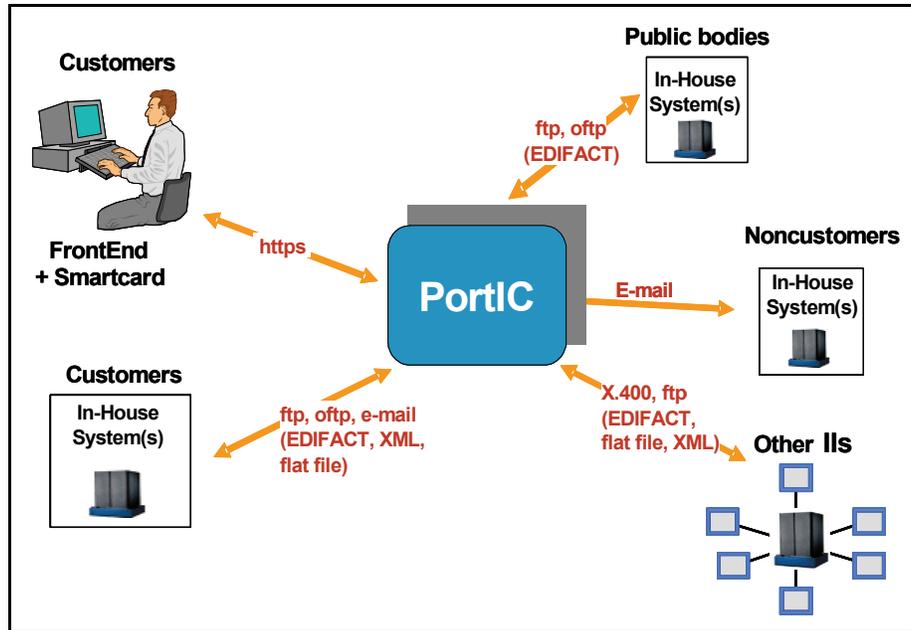
Figure 1. **Technical Actors Enrolled in the PortIC Actor Network**

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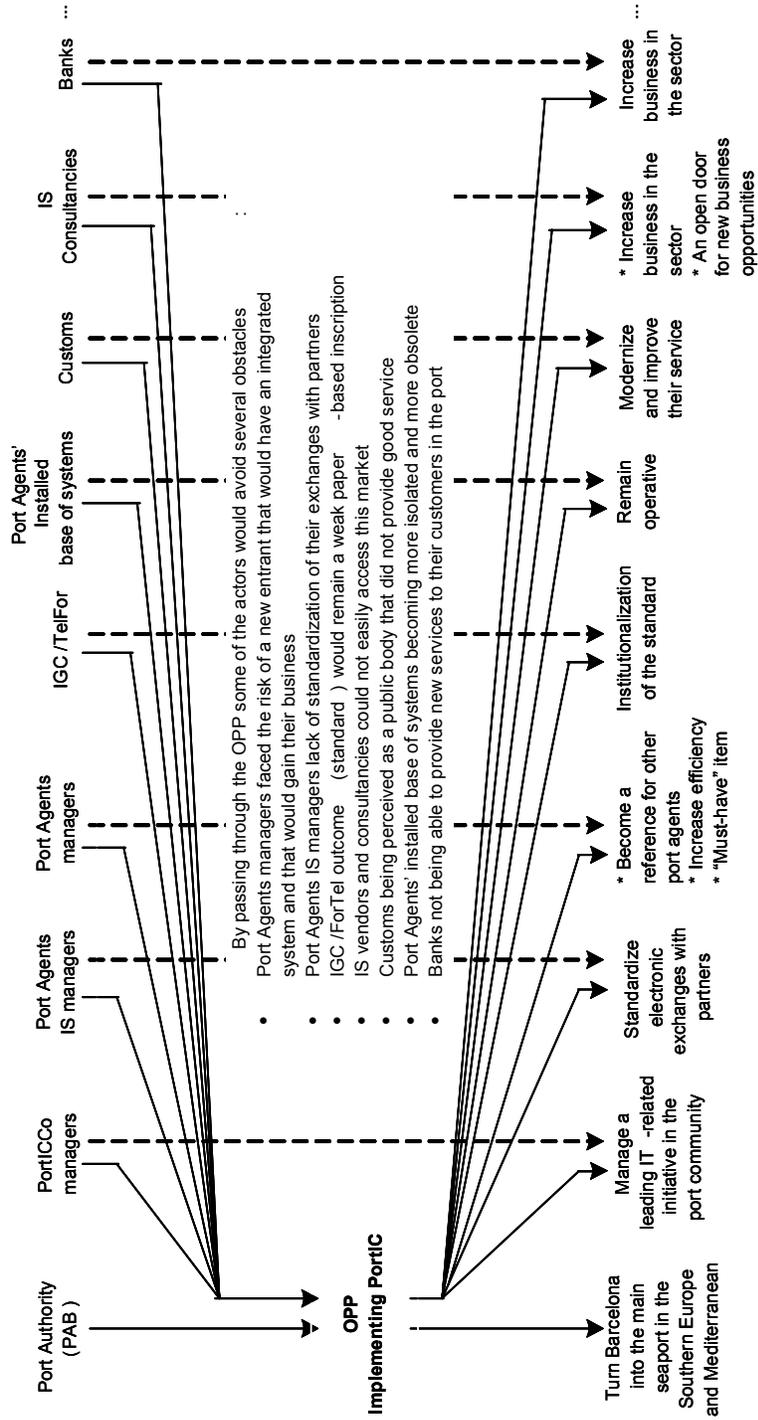
Figure 3. **The OPP, Some of the Actors, Their Goals, and the Obstacles to avoid (based on Callon 1986)**

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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