Published in: Electronic Markets, Vol. 20, Nos. 3-4 (December 2010), pp. 229-240. The final publication is available at www.springerlink.com.

The Difficulty of Studying Inter-organisational IS Phenomena on Large Scales: Critical Reflections on a Research Journey

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Abstract

We argue that certain theoretical commitments that underpin much existing Inter-organisational Information Systems (IOIS) research at small scales become untenable when IOIS are studied at the scale of whole industries and over time periods greater than individual implementation projects. We make this argument by a detailed analysis of the problems we encountered when applying conventional research design methods in the early stages of a five year international comparative study of IOIS in pharmaceutical supply chains in four countries. We found that the large scale of our unit required a move away from the construction of discrete variables (dependent and independent) as well as from input-output process logic, to an alternate modelling approach derived from Structuration theory and Practice theory. We illustrate the revelatory power of this new lens by applying it to two cases. The paper will be of interest to IOIS researchers because we have systematically worked out the reasons for difficulties that limit IOIS research to unit and time scales smaller that the actual phenomenon. Because we refused to limit our own research object in this way, we ventured further into these problematic areas than others.

Keywords: Inter-organisational Information Systems (IOIS), Research Design, IS Theory, Structuration Theory, Practice Theory, Pharmaceutical Industry.

Introduction

Inter-organisational information systems are information systems that span multiple organisations. From a functional perspective, they frequently serve to integrate planning and operational processes across whole supply chains in order to make them more responsive to volatile market conditions. From a collective action perspective, they frequently call for standardisation of interfaces used to connect enterprise information systems. Thus, by their very nature, they are potentially very large organisational phenomena.

However, with few exceptions (Damsgaard and Lyytinen, 1998 and 2001; Johnston and Gregor, 2000; Gregor and Johnston, 2001; Markus et al., 2003 and 2006; Rodon et al., 2008; Reimers et al., 2009; Higgins and Klein, 2011), IOIS have been studied on small time and unit scales such as individual projects and bilateral electronic linkages (Robey et al., 2008). Recently, it has been argued that IOIS need to be studied on the level of whole industries (Steinfield et al., 2005; Reimers et al., 2004).

In this paper we will argue that certain theoretical commitments that underpin much existing IOIS research at small scales become untenable when IOIS evolution and use is studied at the scale of whole industries and over time periods greater than individual implementation projects.

Our method for making this argument is to present in narrative form our own experiences in coming to grips with the complexity of researching IOIS on large scales during a five year international study of structure and evolution of IOIS in the pharmaceutical distribution industry in four countries (Australia, Germany, Ireland, China) (Reimers et al., 2010, 2009 and 2008; Reimers and Johnston, 2008a and 2008b; Reimers and Li, 2008; Klein et al., 2008; Reimers et al., 2004). In this study, we endeavoured to do justice to the phenomenon of interest by defining an unusually large unit of analysis that comprises an industry segment as well as three value chain stages on a timescale that spans decades rather than years or months. We will use our own experiences as data to explain the problems we encountered in this endeavour and how overcoming them required examining the deep theoretical commitments implied in the standard methods of small scale research in IS. We then present two ‘case vignettes’ constructed from data collected in this comparative study. These are not given as empirical evidence for our claims, but rather to point out the explanatory possibilities that arise when the traditional theoretical commitments are given up in favour of new commitments that are more compatible with the organisational scale and timescale on which evolution of industry-wide IOIS use occurs. Thus, the empirical material that we will draw on to motivate our insights are chiefly our own research experiences, which is an unusual approach and therefore needs highlighting to the reader.

The main outcome of our analysis is that the nature of the IOIS phenomenon considered on large scales necessitates a move away from the construction of discrete variables (dependent and independent) as well as from input-output process logic as the main devices for explaining organisational phenomena. Instead, we propose alternate theoretical commitments that accommodate the description of large inter-organisational phenomena over evolutionary timescales. The phenomenon of persistence and evolution of inter-organisational information systems over long timescales has been known for some time and its importance has been acknowledged (Copeland and McKenney, 1988; Short and Venkatraman, 1992). So far, however, this phenomenon has not been approached analytically.

Our main contributions consist of (1) uncovering why the study of IOIS on large organisational and timescales has posed such a daunting challenge for traditional IS research methods and (2) identifying which aspects of the phenomenon become potentially visible when changing to new theoretical commitments that break away from the notions of discrete variables and input-output process logic.

Literature context

The literature on IOIS adoption and use has recently been reviewed by Robey et al. (2008) who categorize it into three topical streams: adoption, organisational consequences, and governance. Adoption research aims to explain adoption through a broad range of factors that Robey et al. group into clusters such as external environment and organisational characteristics (2008, p. 502). Well-known examples in this stream include Iacovou et al. (1995) who, in an exploratory study, suggest three factors to predict EDI adoption among small organisations, namely, external pressure, organisational readiness and perceived benefits, and Teo et al. (2003), who use neo-institutional theory to derive factors for predicting IOIS adoption. Studies on organisational consequences focus on implementation processes as well as implementation results. Typical examples include Christiaanse and Huigen (1997) and Barrett and Walshham (1995) who explain failed attempts to implement IOIS based on detailed analyses of interests of stakeholders. For the purposes of this paper, we can bracket the third stream which is mostly concerned with evaluating the so-called move to the market-hypotheses by Malone et al. (1987).

From a methodological point of view, the adoption and consequences streams correspond closely to variance and process theory approaches widely distinguished in the IS literature (Mohr, 1982; Markus and Robey, 1988). Adoption research can be characterized as based on variance theories because authors typically adopt statistical methods to relate antecedent variables to the dependent variable, usually an intention to adopt. Research on organisational consequences typically views various organisational consequences such as organisational change as a result of a time-extended process which often is an implementation activity.

We here characterize these two streams, in a stylized manner, by their respective underlying ‘logics’, namely prediction and process logic as illustrated in Figure 1. Prediction logic implies that values of two variables co-vary so that a given value of one variable predicts the value of another variable. Process logic explains an observed outcome as the result of a time-extended process acting on given start (input) conditions. Both logics imply that the phenomenon to be studied needs to be limited in terms of its size. For example, in variance theories the IOIS phenomenon is typically limited to an ‘adoption decision’ that is influenced by a finite set of factors. In process theories, the phenomenon is typically limited to timescales of a ‘project’ that can be characterized by certain start conditions converted by specific process actions to end an state, such as organisational consequences.

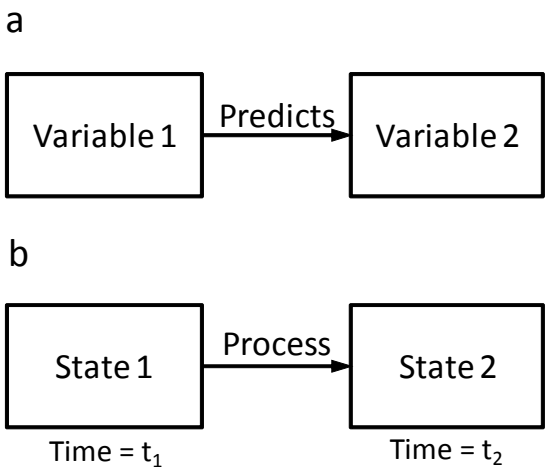

Figure 1. Two main research 'logics' that inform much of the IOIS literature: a. prediction logic; b. process logic.

However, there are examples of studies in the IOIS literature that have attempted to move beyond these small unit and time scales. These include work by Damsgaard and Lyytinen (1998; 2001), Johnston and Gregor (2000; Gregor and Johnston, 2001), Markus, Steinfield, and Wigand (Markus et al., 2003 and 2006; Steinfield et al., 2005), and Rodon et al., (2008). Steinfield et al. (2005) argue convincingly that IOIS phenomena need to be studied on the industry level rather than on smaller scales such as individual organisations and projects. To facilitate such endeavours, these authors have often adopted a hierarchical layered representation of the relevant IOIS environment (see Damsgaard and Lyytinen, 1998, and Johnston and Gregor, 2000, for examples).

In our project, we were initially committed to each of the above two theoretical logics. In this paper, we reflect upon the problems that we encountered in our endeavour, and attempt to show why these problems occur necessarily when expanding the unit of analysis and the relevant timescale from those typical in IS research to those compatible with the IOIS phenomenon. We also offer an alternative to prediction and process logic and illustrate the payoffs that can be gained when moving away from the theoretical commitments inherent in prediction and process logic.

Our initial attempts to model the IOIS phenomenon

In this section, we narrate our intellectual journey as we initially attempted to apply the traditional research approaches to our project. These initial models presented in this section were not ultimately used in the project but are presented here to provide material for analysis in subsequent sections in order to facilitate understanding of the difficulties that occur in applying traditional methods to very large unit and timescale IOIS research. The initial research question, which we had to abandon due to reasons spelled out below, was whether IOIS structure and evolution is mainly shaped by industry level or country level factors.

We began by defining an appropriately large unit of analysis. As IOIS had previously mostly been studied on the level of individual organisations, bilateral relationships and hub-and-spoke networks, we expected to considerably increase explanatory power by extending the unit of analysis to comprise a whole industry segment as well as the suppliers and customers of organisations in that segment. We called this new unit an 'Industry Segment Value System'

(ISVS) because it contained the notion of an industry segment at its core from which transactional relations reached into the upstream and downstream stages of the respective supply chains (cf. Reimers et al., 2004). We placed this unit in a hierarchical 'onion' model with IOIS structure at its centre and the remote environment as the outer layer, as shown in Figure 2.

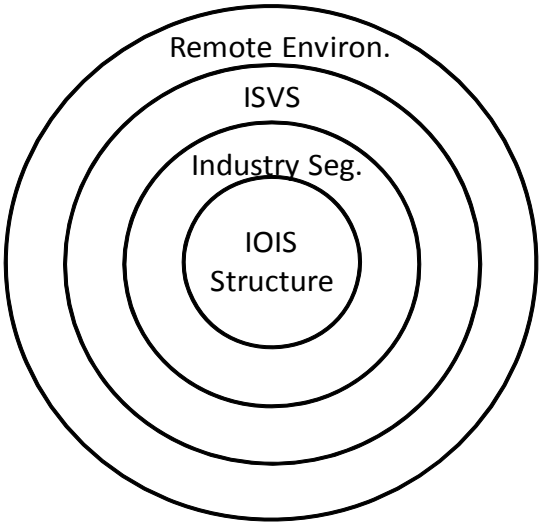

Figure 2. Our hierarchical layering of IOS structure within various levels of environmental structure. Also shown is our new unit of analysis (the industry segment value system, ISVS)

Next, we approached our research question in the standard way in that we tried to identify the influence of two sets of environmental factors, those that reside on the industry level and those that reside on the country level, while assuming that the IOIS phenomenon could be clearly separated from these two sets of factors. In line with the definition of our new unit of analysis, we subsequently separated the industry layer into two layers, assuming that structural variables on each layer could be causally linked to structural properties of IOIS. We recognized, however, that the several layers also influenced one another; these influences were treated as indirect effects. Figure 3 illustrates our early research model.

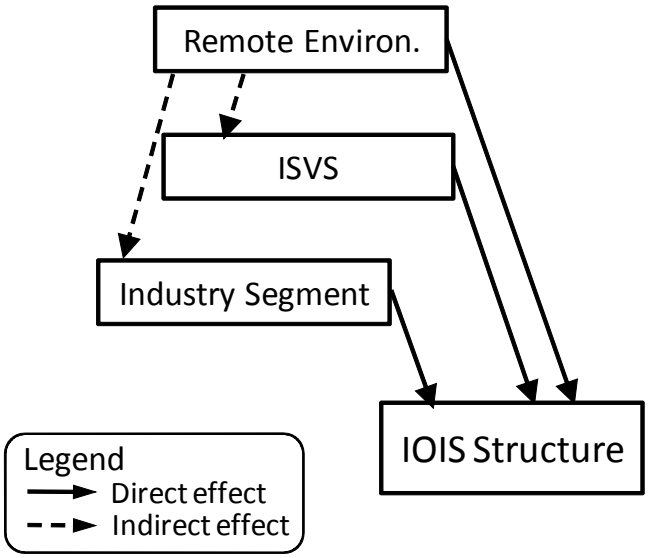

Figure 3. Our early layered model of predictive influence between IOIS structure variables and various levels of environment structure variables. This model results from combining predictive logic (Fig. 1a) with a hierarchy of levels of structural variables (Fig. 2)

To facilitate our search for relevant influence factors, we pursued an eclectic approach by considering a number of theories that seemed pertinent to the explanation of collective action on levels higher than bilateral relations of organisations, such as network theory, neo-institutionalism, industry-life cycle theory etc. (Reimers et al., 2004). We mined these theories to extract possible independent variables on each of our three layers and then formulated hypotheses that related these independent variables to aspects of IOIS that we were interested in. In total, ten theories were used to generate 61 hypotheses, (including 13 hypotheses concerning "indirect effects") based on 40 variables, including dependent variables. Figure 4 provides a partial view of our theoretical model for the ISVS layer.

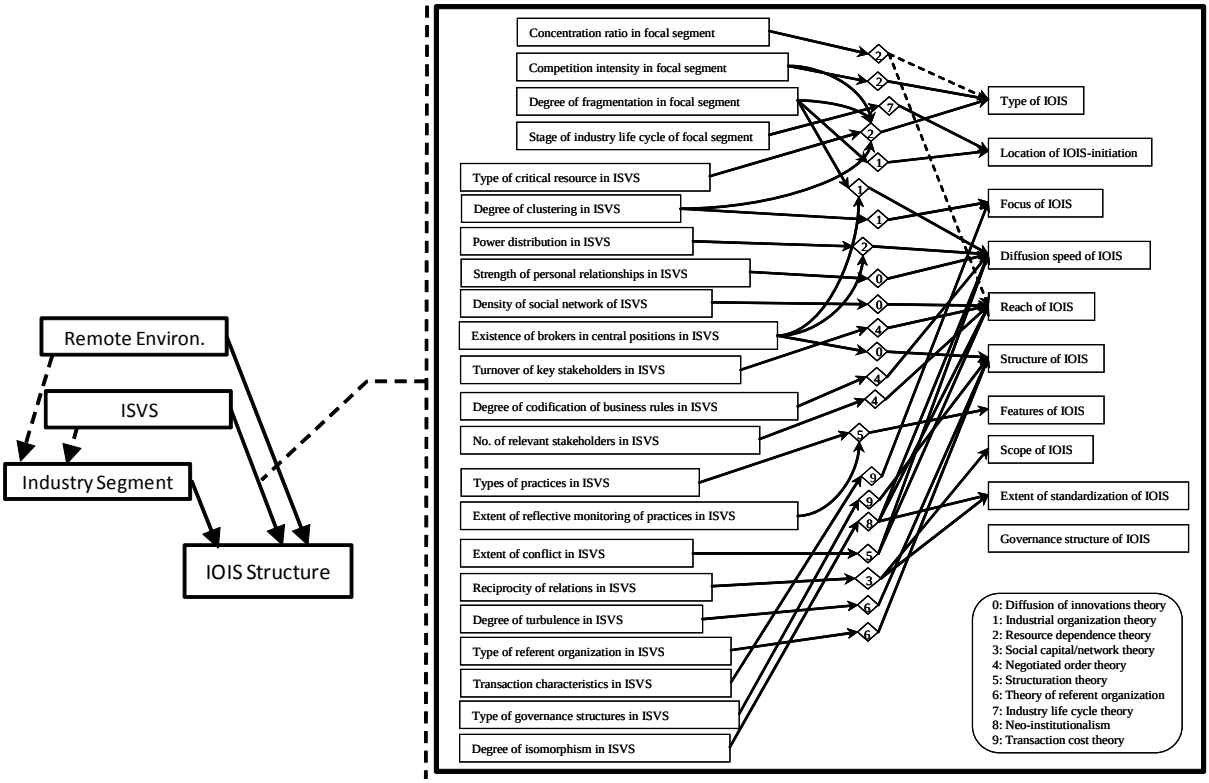

Figure 4. An expanded view of the relationships between variables in our initial theoretical model. The large callout box shows relationships between ISVS layer variables and IOIS variables from a fragment of archival material, superimposed on the schematic model of the text. Rectangles show variables, arrows show associations, and diamonds indicate the theory from which the associations are derived.

In parallel to our theory building process, we started to collect data through semi-structured interviews as part of a multiple case study design. We quickly discovered that the origins of the several systems that we were studying lay in the 'remote' past. Thus, we had to trace the evolution of these systems over timescales that are rather unusual in the study of information systems. For this purpose, we attempted to 'time-index' our variables so that we could organize a timeline of changes in these variables into successive episodes of change processes. This step is represented schematically in Figure 5.

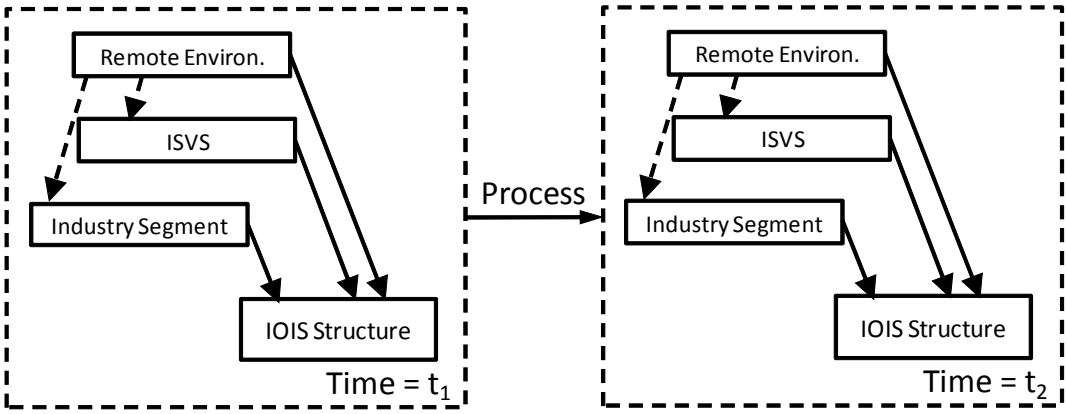

Figure 5. Process logic is added to our layered model to capture change of structures occurring in discrete episodes. The figure depicts schematically the effect of applying process logic (Fig. 1b) to a layer of levels of structural variables (Fig. 2 and Fig. 3)

Encountering two basic problems

However, detailed inspection of the theoretical models described above disclosed two fundamental problems that we term the 'layer model problem' and the 'episode model problem'. In this section we will argue that these two problems resulted from imposing 'prediction logic' and 'process logic' respectively on our hierarchical description of the environment of the IOIS.

The layer model problem originated in combining prediction logic (Figure 1a) with a hierarchical representation of the phenomenon and its environment (Figure 2), resulting in our layered conceptual research model, illustrated in Figure 3.

We found that the conceptual source of this problem was that we had applied prediction logic to aggregates of variables rather than to individual variables. While Figure 3 is a quite legitimate causal model when the boxes represent discrete variables, in our problem the boxes represented aggregate variables. This became clear when the individual hypotheses were examined. The individual predictive precursor variables could not be uniquely and consistently allocated to separated environmental boxes, i.e. layers, or even consistently to environment versus IOIS structure boxes. For example, some variables associated with the aggregate 'IOIS structure' turned out to be also part of the remote environment, such as 'type of data communication network'. Thus, for some hypotheses, that particular variable would have to be included in the aggregate 'remote environment' while for others it would have to be included in the aggregate 'IOIS structure'. In another case, the variable 'national culture' was seen as belonging to the aggregate 'remote environment' (people in a country learn norms etc. as part of their basic education) as well as to the aggregate 'ISVS' (e.g. the role of 'Guan Xi' in Chinese industry; see, cf. Martinsons, 2008). Thus, while pairs of variables involving national culture could be related by causal hypotheses, these pairs could no longer be unambiguously associated with our larger aggregates of variables.

The problem is that when a phenomenon is viewed on such a large scale with such a large collection of variables, individual pairs of predictive relations between pertinent variables cannot be cleanly assigned to hierarchical layers of influence. We contend that this will inevitably occur when complex multi-scale social phenomena are viewed at a large enough unit of analysis from the vantage point of prediction logic.

Likewise, the episode model problem arose when we combined process logic (Figure 1b) with our hierarchical description of the phenomenon (Figure 2), resulting in a research model for describing IOIS change over time as illustrated in Figure 5.

This problem manifested itself when we started to collect data through interviews. Many of our interviewees referred to history in order to explain the status-quo of the IOIS that we were studying. At that point, we realized that the history of these systems was crucially important for understanding their structure. Consequently, we had to reconstruct their history in terms of how the several aggregates of variables were related to one another over time. We therefore attempted to time-index structures so that an IOIS structure at time $t+1$ could be seen as the outcome of a process that took that structure at time t as its input. In the context of our research model, we had to cope with multiple structures on varying scales, i.e. our layered model. The episode model problem occurred because change processes in a layered model typically also operate on different timescales. For example, in some cases collective action (as a process) on the IOIS level led to the development of semantic standards for product identification. Thus, IOIS structure was changed. However, this change also fed back into the layer of the industry segment where these product codes started to increase entry barriers. Yet, this process occurred much more slowly.

Episode models are often used when possible causal influence between variables in both directions is encountered. In this way, conventional causality can be retained in each time-bounded episode. However, when time scales are long, and especially when the phenomenon is organised on multiple hierarchical layers with differing timescales of change, such an episode approach becomes infeasible. Again, we contend that this will inevitable occur when the timescale and size of socio-technical phenomena become large enough.

Overcoming the layer and the episode model problems

The two problems ultimately resulted from forcing the large number of relevant variables of a large scale social phenomenon into restrictive prediction and process logics more appropriate to phenomena on smaller scales. The layer model problem characterizes a situation in which it becomes infeasible to group variables into larger clusters in a way that would allow for making statements about aggregate causal relationships among these clusters. Thus, our original research question, whether IOIS are influenced predominantly by industry-level or country-level factors (variables), could not be upheld. The episode model problem arises when state variables cannot be consistently arranged into episodes such that all relevant state variables at one frozen moment in time can be explained as the result of a process acting on state variables from an earlier frozen moment. The episode model problem prevented us from explaining IOIS evolution from the vantage point of process logic. We argue that, while layer and episode models are certainly valid across a broad range of phenomena at smaller unit and time scales, they become infeasible when the scale of the phenomenon under consideration becomes large.

An obvious solution to the two problems would have been to scale down the phenomenon to be researched, e.g. by focusing on select aspects of IOIS (such as semantic standards or strategic effects) or on a smaller unit of analysis (such as bilateral linkages). However, we had argued theoretically that IOIS need to be studied on larger scales (Reimers et al., 2004) and were encouraged in this assessment by other researchers (Steinfield et al., 2005). Moreover, our initial interviews suggested that current IOIS arrangements need to be understood in view

of their long history spanning more than two decades. We therefore decided to retain our definition of the phenomenon of interest and, instead, change our overall research approach.

In a process that is difficult to reconstruct retrospectively we developed a new theoretical approach that can be characterized by a fundamental shift in theoretical assumptions. As we had previously been attracted by the handling of structures in Structuration Theory, this was an obvious starting point for our search. We found a natural extension of Structuration Theory, and one which allowed for better operationalization for an empirical project, in Practice Theory. Here, we relied mostly on two versions, one developed by Wenger and Lave (Lave and Wenger, 1991; Wenger, 2002) which revolves around the concept of Communities of Practice (CoPs) and one developed by Reckwitz (2002), among others, which emphasizes the role of the human body in practice. The latter extends Structuration Theory in a way which allows for incorporating technology into the theory that Giddens, in his classical formulation (Giddens, 1984), did not treat as a structural element. Once seen as an integral part of social practice, as proposed by Reckwitz (2002), the body becomes the complement of material structure in the human environment, and the body interacts with it in the same way that the mind interacts with ideas and morality. This allowed us to treat technology as a structure similar to other structural elements, such as norms and ideas (while other authors who rely on a structurational paradigm, tend to treat technology as external to practice, see e.g. Pentland and Feldman, 2008).

We further drew on the writings of Wenger (2002) to obtain a more detailed description and potential operationalisation of the process of structural reproduction. Wenger describes the way the structural and participatory elements of practice are mutually constituted through a process of enacting and perceiving behavioural patterns within a Community of Practice and thus provides a theoretical lens for identifying the relevant social context within which the technical systems that interested us, as structure, are reproduced.

Finally, we drew on a framework developed by Child (2000) that studied and compared the influence of national culture on organisational phenomena and therefore seemed appropriate for our purpose. That framework distinguished between three broad constructs: institutions, material forces (influence of technology and economic logic) and ideational forces. The inclusion of ideational forces (influence of ideas and discourses) was attractive to us because of the influence of "organisational visions" in IS and IOIS (Swanson and Ramiller, 1997). By moving away from the organisational contents in these constructs, such as specific organisations that, for example, might be seen as institutions, we arrived instead at distinguishing between three structural dimensions of organizing practices, namely, material structure (including technology and economic constraints), moral norms (normative structure) and rationales (ideational structure). While we recognize that in the literature other ways of carving up the structural dimensions exist, we submit that the three-fold distinction introduced here brings to the fore important aspects of the IOIS phenomenon, as illustrated in the next section.

Our theory building efforts, the results of which have been laid out in detail elsewhere (Reimers et al., 2010), can be summarized by two theoretical moves. First, we abandoned the view that the relevant phenomenon can be described by aggregates of system and environment *variables* whose values co-vary (prediction logic). Instead, we now characterized the phenomenon in terms of the experienced world of practitioners and described the phenomenon of IOIS adoption and use in terms of evolution of *IOIS practices* which are divided for convenience into three dimensions. This move is illustrated in Figure 6. Second, we abandoned the view that changes in the phenomenon (its 'dynamics') can be described as

changes of states linked by processes (process logic) in favour of a view that sees the dynamics as the mutual constitution of the durable aspects of practices (ostensive structure) and the ephemeral instances of practice performances (performative patterns), i.e. as duality of structure, as illustrated in Figure 7.

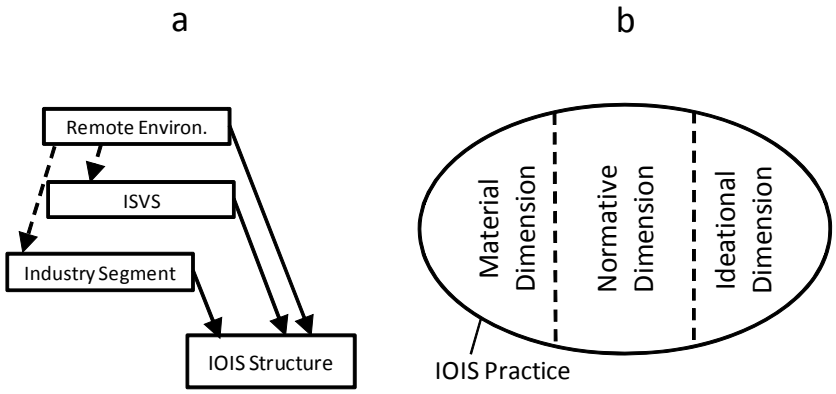

Figure 6. From a layered model of structural variables (a), to a dimensionalized model of IOIS practices (b).

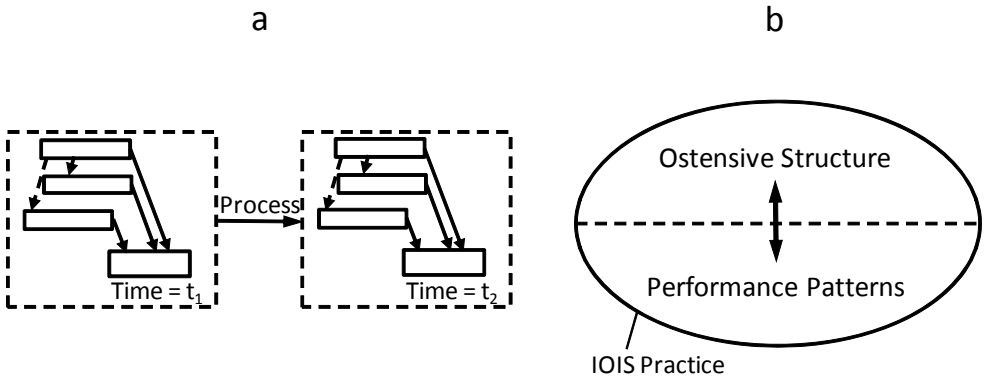

Figure 7. From an episode model of temporal causal processes (a), to mutual constitution of durable structures and patterns of performance of IOIS practices.

Combining these two theoretical moves yielded a new theoretical lens (see Figure 8) that we used for understanding and explaining structure and evolution of IOIS. The case vignettes in the next section will illustrate the value of this new theoretical lens in bringing important new aspects of the phenomenon to the fore and allowing a description of the continuous development of IOIS on an evolutionary timescale.

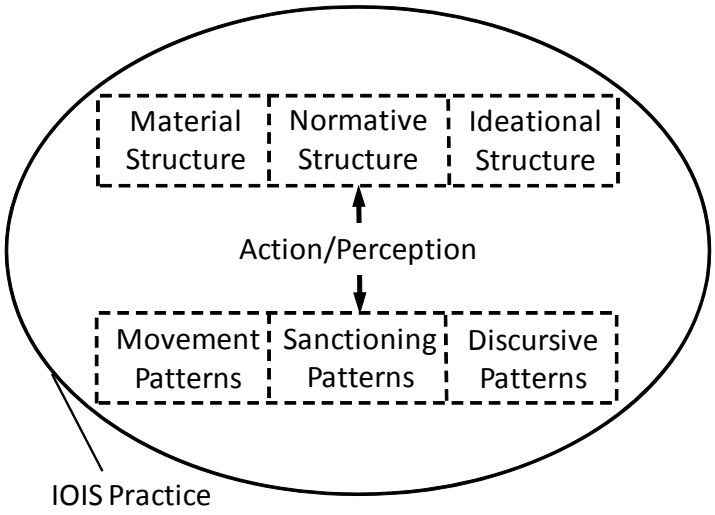

Figure 8. The resulting model of IOIS practices. The rectangles in the figure do not denote discrete variables and the arrows do not denote simple causal relations. Rather, the diagram depicts that IOIS practices are analysed into dimensions (horizontally), and into structures and patterns (vertically) which are mutually constituting.

Case vignettes: Seeing the phenomenon in a new light

Two cases about IOIS in the Australian and Chinese pharmaceutical wholesaling industry have been selected from a broader sample of cases that were developed within our research project. We have selected these cases for the purpose of illustrating the new aspects of the phenomenon that are brought to light by our new theoretical lens and not for empirically testing it. We do not claim that these cases are in some sense representative. However, from our long involvement in the study of IOIS in pharmaceutical distribution across several countries we know that these are not extreme or outlier cases.[1]

From proprietary to (quasi) open systems: IOIS in the Australian pharmaceutical wholesaling industry

In the early 1980s, drug wholesalers in Australia started to distribute handheld computers -- so-called PDE devices -- to pharmacies which they could use for ordering. This was done by scanning shelf labels on which a barcode was printed which identified a particular drug. The required order quantity would then be added either automatically or manually and an order would be sent once the device was placed into a cradle that set up a data transmission connection to the wholesalers' internal systems. The product codes -- which were and still are called PDE codes -- as well as the communication protocols embedded in the cradles were

[1] The Australian case is based on nine interviews conducted between April 2006 and September 2007, the Chinese case on 14 interviews conducted between October 2004 and July 2007. All interviews lasted between 45 minutes and 2 hours; the Australian interviews were recorded and transcribed; the Chinese interviews, due to concerns by interviewees, were documented by students attending the interviews instead of being recorded; immediately after each interview, all interviewers jointly prepared a single set of interview minutes in Chinese and English. Interviewees were drawn from organisations involved in drug distribution including manufacturers, distributors, pharmacies, IT vendors and regulatory authorities. In addition, we complemented our data by publicly available documents, mostly in the form of websites. For further details on our data collection methods see Reimers and Li (2008) concerning the Chinese case and Reimers et al. (2009) concerning the Australian case.

proprietary to each wholesaler. Thus if a pharmacy wanted to order electronically from multiple wholesalers they needed to install and use multiple PDE systems. From the wholesalers' perspective, the measure followed a strategic differentiation rationale as electronic ordering was seen as cutting-edge technology in service innovation.

In the 1990s, pharmacies began to use so-called POS-systems (for Point of Sale systems) that recorded sales and performed some other functions (such as inventory management). For software vendors to be able to sell their systems, they needed to ensure electronic ordering was supported. This was achieved by incorporating the proprietary PDE codes of the several wholesalers into the systems' databases as well as by implementing the several wholesalers' proprietary communication protocols. Maintenance of PDE codes and communication protocols was done by the software vendors; while this task was tedious, it was feasible because of the small number of wholesalers (which has remained stable at three for the main 'full-line' wholesalers over the time that we covered in our case study).

In the first years of the 2000s, several outside attempts to replace this system with a more open-market approach in which drug orders would automatically be routed to the lowest-price offer were fended off by the wholesalers. A government initiative that aimed at linking every member in the drug distribution chain -- manufacturers, wholesalers, pharmacies -- failed to the extent that the system ultimately was only used by manufacturers to 'order' drugs from wholesalers that their sales reps had previously sold directly to pharmacies while pharmacies did not use this system for ordering. Most recently, a group of POS vendors have established a common Internet-based hub which is used to connect POS systems of pharmacies to the wholesalers' internal systems thus replacing the proprietary communication protocols (and, consequently, the need to maintain these in the POS systems). Yet, the proprietary PDE codes are still being used by this new hub (in spite of the fact that the EAN product code is now available on almost all drug packages as well) implying that POS vendors still have to maintain the cross-reference files. Moreover, pharmacies continued to rely on the old PDE devices for stock keeping purposes and partly for ordering, albeit the fraction of electronic orders that are placed through these devices is continuously declining.

This technology-focused account leaves out important aspects of the evolution that became visible once we applied retrospectively our practice model. The whole system can be described as three interconnected practices, the wholesalers' practice of maintaining and operating the electronic ordering system, the practice of IT vendors that consisted of maintaining pharmacy software as well as the proprietary communication protocols and a cross-reference database that mapped the PDE codes onto one another, and the practice of stock replenishment of pharmacies. Here, we focus on the wholesaler practice. Specifically, we saw how rationales and normative stances accumulated that reinforced changes in the material dimension over the three 'eras'. For want of space we cannot trace all these changes in this paper and must limit ourselves to some poignant examples.

The original rationale -- service differentiation through technology -- was still noticeable in our interviews. However, interviewees conceded that the use of proprietary ordering systems, while effective in the past, was currently not feasible but also speculated that, in the future, this might change again. Moreover, wholesalers expressed dissatisfaction with a decreasing degree of loyalty of pharmacies. In the past, pharmacies often perceived a moral obligation to order from the one wholesaler who has helped them to found their business (e.g. through low-interest loans). However, this moral bond has withered and wholesalers cannot rely on it any longer. Yet, wholesalers still express their expectation that pharmacies *should* be loyal, thus

adding a normative dimension to the original rationale for introducing proprietary ordering systems.

Along with the POS-based electronic ordering facility came a new rationale on the side of wholesalers. They saw a need to demonstrate their service performance to potential customers -- pharmacies -- as they left their original regional niches and invaded one another's markets as they started to operate on a national scale. The proprietary PDE codes printed onto shelves turned out to be a hindrance as a pharmacy first had to 'convert' to a new wholesaler by having all shelf labels replaced (wholesalers would typically offer to subsidize this conversion process which often also involved the replacement of the pharmacies' look-and-feel as wholesalers often also took over marketing functions for pharmacies). Thus, wholesalers saw the benefit of relatively easy switching between wholesalers when placing orders, a capability that came with the POS systems that contained all three PDE codes and communication protocols. Again, we found a normative dimension to this change as well as the above ideational change. On the one hand, wholesalers treated POS vendors who maintained accurate cross-reference files with high respect; on the other hand, they expressed disapproval of pharmacies that did not do 'due diligence' when selecting their POS package, specifically with regard to the respective vendor's ability to accurately maintain PDE codes and communication protocols.

From the perspective of our initial model based on prediction logic one would have to select one or several structural dimensions as independent variables. For example, ideas about IT-based competitive advantage may be perceived to drive technology deployment and use. Alternatively, the initial installed technical base may be perceived to determine later development stages. However, the above account suggests that ideas were reinforced by norms and moderated by technology. For example, technical barriers of switching between wholesalers softened the strategic rationale of creating competitive advantage through proprietary technology deployment. Likewise, the initial installed technical base did not determine subsequent developments; initially, wholesalers had, de facto, locked-in pharmacies through their PDE systems; however, the appearance of POS systems along with routines of maintaining cross-reference files as well as new strategic rationales and norms, has led to a quasi open system in which pharmacies can, with relative ease, route orders to any one wholesaler. Yet, wholesalers prevented establishment of systems that would automatically route drug orders based on price alone.

Overall, we saw how these systems changed in the three dimensions that we have distinguished in our model. Particular instances of rationales, norms, and material structure would either reinforce or, occasionally, contradict one another. Also, elements of earlier periods were still visible in the utterances of our interviewees and co-existed along with newer elements. It seems that these non-technical dimensions greatly contributed to both the systems malleability and its persistence as, on the one hand, new material structures were complemented by ideas and norms and, on the other hand, these norms and ideas could be extended and modified to provide 'landing strips' for new technical components that, from a technical logic, contradicted earlier components. Over this long timescale, no single structural dimension could be identified as the sole driving cause, i.e. the independent variable. Rather, all three dimensions were interwoven in a web multiple two-way causal links.

Hunting for stability: IOIS in the Chinese pharmaceutical wholesaling industry

In China, the use of IT to support the distribution of drugs began in the early 1990s in Henan province. There, provincial government attempted to centralize all drug procurement, supported by an e-commerce system. While this practice was discontinued soon after its introduction upon intervention of central government which ruled that governmental agencies should not engage in business activity, the software was sold to a private company which worked to introduce similar systems in other provinces, including Beijing (which is a province as well as a city). The system's function was, roughly speaking, to support a public tendering process in which manufacturers could bid on 'substances' that were required by hospitals.

After three years of preparation, a first bidding round was initiated in Beijing in 2004 based on a modified version of the original Henan system. One addition to the system's functionality was that hospitals could also place their drug orders to wholesalers using the system once the drugs available for procurement had been established in the preceding bidding process. While the industry lobbied against the system, the percentage of transactions that were conducted through the system rose steadily to 100% two years after its introduction (2006). At the same time, however, provincial government discontinued the bidding practice, basing all transactions on the results of the 2005 bidding round. Thus, the system has essentially morphed from a reverse auction type electronic marketplace into an electronic ordering facility.

Again, for want of space, we cannot detail all the facets that became visible once we applied our new model to this evolution process and need to confine ourselves to some examples. Regarding the ideational dimension, the rationale underlying the system changed significantly: initially, it was claimed that centralisation of drug procurement is only feasible with e-commerce; as resistance to the system mounted, a new rationale was offered, specifically that the system was conducive to modernizing the industry; this rationale was followed by the argument that using the e-commerce system would support monitoring of hospital procurement behaviour (hospitals have strong incentives to order high-margin drugs as a significant portion of their revenue stems from the sale of drugs while, in the bidding process, typically low-margin drugs, so-called generics, are selected). As the number of wholesalers in the province dropped significantly -- from around 200 to about 120 -- the system was credited by its supporters with enabling and enforcing this industry consolidation process.

Regarding the normative dimension, we similarly found a succession of expectations as the system evolved from an electronic market towards a transaction platform. Initially, manufacturers were seen as the 'villain' since it was they who bribed hospitals, a practice that was intended to be undermined by the auctioning system; later on, the doctors were accused of being the root cause of China's ailing healthcare system, concurrent with the shift of emphasis regarding the system's main rationale as helping to monitor hospital procurement behaviour. Finally, government was blamed for providing contradictory incentives.

Again, we focused on one practice in tracing these changes in the normative and ideational dimensions, specifically that of the newly established intermediaries that operated the e-commerce systems. In total, there were three such intermediaries operating in Beijing over the time covered by our case study. The system contained three more practices: that of wholesalers dealing with hospital orders, that of hospitals dealing with drug procurement, and

that of the 'bidding centre' which was established by nine separate government agencies to run the bidding process.

In contrast to the Australian case, the Chinese electronic ordering system evolved by replacing instances of its (material, normative, ideational) structure in short succession. By contrast, the Australian system evolved in a more incremental way such that small changes in material, normative and ideational structures were layered on one another with older ones persisting in a toned down way. Indeed, for the Chinese case it is problematic to speak of an 'electronic ordering system' as this function only recently became the system's focus; initially, one would have more appropriately referred to it as an electronic market. Yet, there are strong elements of continuity, resulting from continued promotion of the system by the main actors, but also because its material manifestation has changed only slightly over the 15 years considered here.

Again, the system's evolution does not allow for singling out one structural dimension as the independent variable. Ideas concerning the role of intermediaries seem to have a much weaker influence than in the Australian case, yet, these ideas have played a crucial role in the system's evolution. For example, centralisation of drug procurement was predicated on the idea that this would become feasible only if based on the then-new technology of e-commerce. Norms probably had a stronger influence as the system was meant to help fix China's ailing healthcare system; yet, moral expectations have also changed with alternating usage patterns. Monetary and legal measures have played a role but were similarly enforced in a flexible manner that took into consideration changing ideas and moral stances. While the technology often failed to enshrine regulatory ideas, increased efficiency of transaction processing changed the overall attitude prevailing in the industry from resistance to cautious embracement. Overall, the system's evolution speaks of a volatile and fragile character and can be characterized as hunting for a stable accommodation of idea, norms and material manifestation.

Together, these two case vignettes show what new aspects become visible once our new theoretical lens is applied to the phenomenon. Norms and ideas are demonstrated to be tightly interwoven with the evolution of the systems' material manifestations. If one were forced to explain the phenomenon when stripped down to its material dimension, an important aspect of the phenomenon would have been left out of the picture. The importance of these other dimensions consists of linking the evolutionary steps of the systems' material manifestations over long stretches of time on the one hand, and of providing a means to relate material manifestations to norms and ideas in a way that does justice to the mutual interrelatedness of norms, ideas, and material manifestations. Thus, through our theoretical lens we can create a description of the phenomenon as extended over large organisational and time scales. In contrast, within traditional research approaches there would be no justification to treat the several material manifestations as bound to such a large phenomenon; instead, one would have had to treat these as discrete, small scale phenomena.

Conclusions

In this paper, we have described how, in a large, collaborative and international research project, we have tackled a series of theoretical problems in our original research design which led us to four findings that we consider important for IOIS studies. First, we found that traditional approaches dominant in the IS literature were inadequate to analyse the IOIS phenomenon when viewed on large organisational and time scales. Second, we uncovered that

this difficulty is related to two deep theoretical commitments underlying traditional research approaches which we termed 'prediction logic' and 'process logic' respectively. Third, these two logics necessarily limit the unit of analysis to small organisational and time scales, indicating that when researching sufficiently large inter-organisational phenomena based on these two logics, one will encounter the problems that we encountered. Fourth, we found that by changing these deep theoretical commitments we were able to describe the phenomenon in a way that is compatible with the large organisational and time scale that it requires.

Our two novel theoretical moves consist (1) of giving up the construction of discrete variables (which might then be further separated into independent and dependent variables) in favour of 'dimensionalizing' the phenomenon in a way that suits the research question (in our case these dimensions were norms, ideas, and material manifestations of practices) without privileging one of these dimensions in terms of explanatory precedence, and (2) of refraining from freezing certain aspects of the phenomenon in time (such as input and output states) and instead of acknowledging the continuous mutual constitution of the durable aspects of practices (ostensive structure) and the ephemeral instances of practice performances (performative patterns).

We submit that these findings are a significant contribution to the literature because, for the first time, we have systematically worked out the reasons for the difficulties that researchers have often been confronted with when addressing large scale organisational phenomena such as IOIS and that usually forced them to limit the phenomenon to smaller scales compatible with traditional research approaches. Because we refused to limit our research object in this way we ventured further into these problematic areas than others have done previously. While our findings might be of import in many areas of the IS discipline and probably even in the area of general organisational theory, they are of special importance for the study of IOIS as these by their very ambition are large scale organisational phenomena.

Regarding future research, our findings suggest a tantalizing question: does one have to give up the aim of predictive explanation altogether when tackling large scale organisational phenomena? We speculate that there are two possible routes for future research. The first one would be the interpretivist or hermeneutic route (Orlikowski and Baroudi, 1991) on which the aim of predictive explanation has been shed. Developing hermeneutic accounts of IOIS poses a challenge in its own right simply because the phenomenon is so large. The second route seems to lead into entirely uncharted territory in organisational theory; the idea for this route is to distinguish between theories of first and second order. First-order theories serve to create an 'interpreted data layer', second-order theories then operate on this layer by developing hypotheses, according to the standard research logics, that predict changes on that layer. In this way the unmanageable complexity of the 'raw' data is reduced by the use of a theory-based coding scheme. The theoretical lens that we have developed and presented in this paper would then qualify as a first-order theory that raises the phenomenon to a more abstract level on which new and important broad aspects become visible. A possible second-order theory operating on the level of this theory-loaded description of the phenomenon could then be, for example, an evolutionary theory that explains changes on this layer with reference to hypothesized evolutionary mechanisms that, in themselves, might not be observable. We have already begun to explore this novel approach to taming data complexity (see Reimers and Johnston, 2008).

Acknowledgements

The first and the third author would like to acknowledge support by the Deutsche Forschungsgemeinschaft, grant number 1328/2-2.

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