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# Studying IOIS as Structurally Coupled Systems

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## **Studying IOIS as Structurally Coupled Systems**

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### **Abstract**

*The complexity of studies concerning the development of inter-organisational information systems (IOIS) over large timescales poses severe challenges on existing models and theoretical frameworks. Such 'evolutionary' research requires multiple perspectives on the phenomenon in order to account for changes as well as persistent elements of the IOIS. In this paper the theoretical concept of 'structural coupling' derived from autopoietic theory is proposed as a means to conceptualise the required alignment of independent organisations that venture into an IOIS. The need for a new concept is motivated against the backdrop of a case study covering the evolution of an electronic ordering system over almost three decades. Subsequently, the case study is used to illustrate the applicability of the concept to the empirical data. The paper finds that conceiving IOIS as structurally coupled systems offers a new and promising venue to study these systems on large timescales.*

**Keywords:** inter-organisational information system, IOIS, evolution, autopoiesis, structural coupling, electronic ordering

### **1 Introduction**

In their seminal paper Cash and Kosynski (1985) define inter-organisational systems as automated information systems shared by two or more companies. In the past IOIS were primarily set up as proprietary systems providing electronic linkages in dyadic business relationships. Today, scholars increasingly report of industry- and even nationwide IOIS resting on open standards (Lyytinen & Damsgaard, 2011, Reimers, Johnston, & Klein, 2010, Steinfield, Markus, & Wigand, 2011). Furthermore, IOIS are mostly studied on the timescale of single projects rather than several decades (Reimers et al. 2010). Especially in studies of the latter type adequate theoretical tools are needed that take into account the changing nature of technology throughout time (Robey, Im, & Wareham, 2008).

The paper is motivated by a case study that covers the development of an electronic ordering system over almost three decades. Lyytinen and Damsgaard (2011) urge scholars to look at the single adopting organisation when investigating IOIS. They propose a typology of IOIS configurations, which may guide the analysis. In similar vein, this paper sketches three distinct research perspectives on the phenomenon. Each perspective enriches the understanding of the evolution of the IOIS by taking different aspects of context into view. The case study is used as an illustrating empirical backdrop.

Common definitions of IOIS identify three main traits: IOIS span organisational boundaries (1) meaning that independent organisations are entering a relationship. Second, the IOIS requires the coordination of some activities (2). Third, the adoption and use of IOIS is generally associated with organisational changes (3) that are either required for adopting the IOIS or are resulting out of its use. This paper investigates how to conceptualise this notion of ‘alignment’ for IOIS research from an evolutionary point of view. In doing so, the theoretical concept of ‘structural coupling’ is proposed and evaluated as a promising candidate. The paper finds that conceiving IOIS as structurally coupled systems resonates well with studies of IOIS over large timescales as well as with the different perspectives of complexity. As such it may contribute to the development of an evolutionary theory of IOIS.

The remainder of the paper is organised as follows. The next section gives a brief overview of the case study, which is subsequently used to illustrate the three research perspectives. Section 3 serves as an introduction to autopoietic theory and structural coupling as the core concept of this paper. Next, a case vignette depicts the benefits of conceiving IOIS as structurally coupled systems on an empirical level. In the following the benefits and shortcomings of the approach are discussed on a theoretical level.

## **2 Complexity in researching IOIS over large timescales**

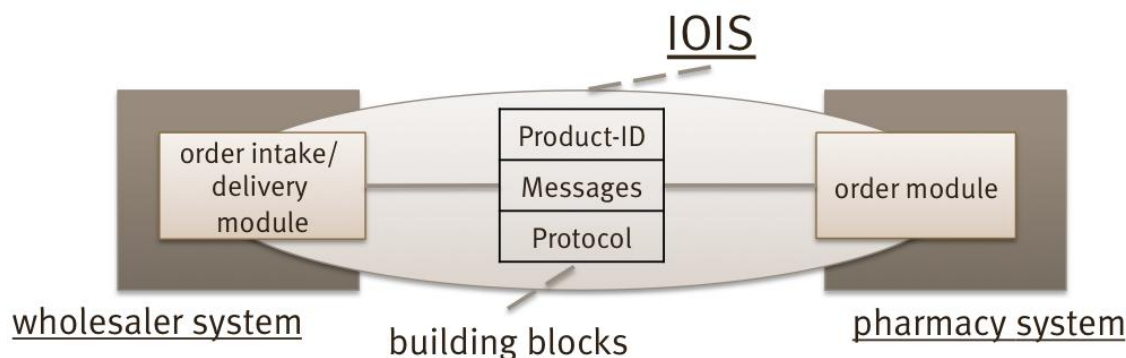
This section sketches the case material underlying the argumentation of the paper. Subsequently, three perspectives on researching IOIS over large timescales are derived from the case. The perspectives serve as a motivating background for developing the new theoretical concept in the next section.

### **2.1 Electronic Ordering in the Pharmaceutical Distribution Industry**

The paper bases on a historical reconstruction of the development of an electronic ordering system between community pharmacies and pharmaceutical wholesalers in Australia. The empirical data collection was carried out as part of a larger research project over the last 4 years that involved similar ordering systems in other countries as well (Klein & Schellhammer, 2011). Here I just give brief overview of the developments with regard to the IOIS over the last 30 years. A more detailed description has been published elsewhere (Klein & Schellhammer, 2011).

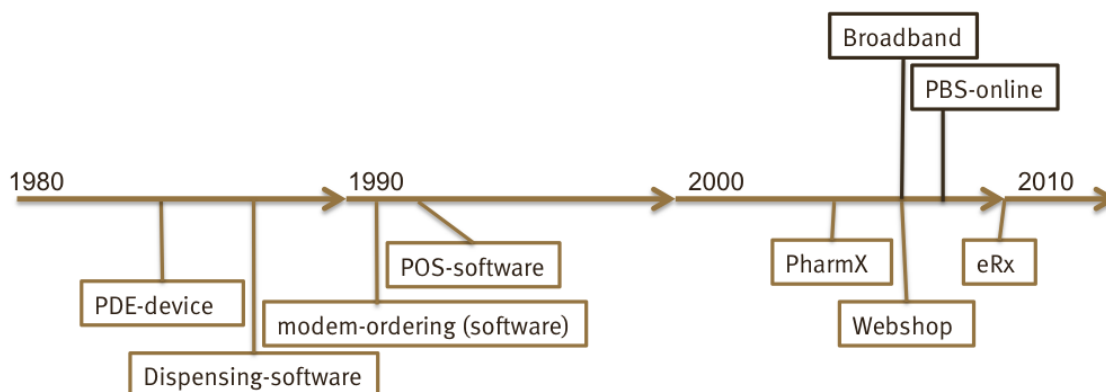
In the early 1980s, the wholesalers developed small handheld devices (PDE-device) that enabled pharmacists to scan barcodes off their shelves and transmit orders to the wholesaler system via dial-up connection. At the time, each wholesaler chose proprietary specifications for the IOIS, i.e. product identifier, message structure,

communication protocol. These building blocks of IOIS are still in existence today and core to the analysis of this paper. Despite the proprietary character of these core elements several evolutionary stages of the IOIS can be reported. Figure 1 depicts the unit of analysis.



**Figure 1:** Building blocks of IOIS

Each PDE device permitted the transmission of orders to only one wholesaler. Thus, pharmacists needed to install multiple devices in parallel if orders were to be sent to multiple wholesalers. Dispensing software was rolled out to pharmacies in the late 1980s and early 1990s. This software is used by pharmacists to process prescription data, to maintain patient medication records as well as dispensing information. In the 1990s the proprietary specifications were implemented as a part of pharmacy software (POS-systems) allowing pharmacists to route orders to all three full-line wholesalers via dial-up modems. In 2006 a joint venture of software vendors introduced an internet-based ordering gateway (PharmX). It relied on a broadband connection. While all wholesalers subscribed to this ‘new’ channel, the software vendors are still required to cater for all three proprietary sets of specifications. Since then, some wholesalers introduced web shops for their customers. These allow pharmacies to check stock-levels, place orders and review their account. The transmission of electronic prescriptions via the eRx-system is the latest development albeit it concerns the interconnection between GPs and pharmacies.



**Figure 2:** Major development stages in the Australian IOIS

Given the technical changes in the environment as well as the friction caused by the proprietary specifications, their persistence is surprising. As part of the quest to account

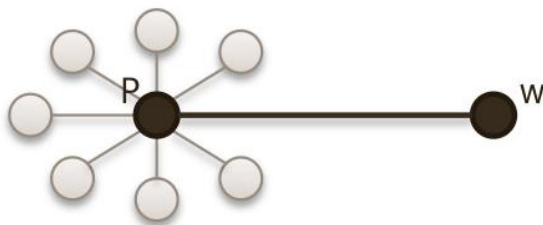
for the evolution of IOIS in general, the explanation of their emergence, diffusion and persistence has been a major focus of the research project. The question why the proprietary specifications persisted over time instead of being replaced by a standardised solution is guiding the subsequent analysis.

## 2.2 Three Perspectives on IOIS

The area of study portrayed in the previous section is not atypical for IOIS-research in general. Thus, the question arises as to why traditional approaches are inadequate to study such phenomena.

Researchers examine organisational and environmental characteristics as variables that explain the adoption decision (Reimers et al. 2010). Traditional analysis seems to focus on the characteristics of the individual organisation and its evaluation of the benefits to adopt an IOIS (Lyytinen & Damsgaard, 2011). As such IOIS are treated like other IT implementation decisions. Seldom the relation between the actors itself and the particular way it technically manifests is subject to investigation. This paper, however, highlights the relational nature of IOIS. The analysis is structured along three research perspectives. They are closely linked to the typology of IOIS configurations (dyadic, hub&spoke, industry) proposed by Lyytinen and Damsgaard (2011).

Reimers and Johnston (2008) argue that the explanation of the continued existence of IOIS is underdeveloped in information systems research (ISR). In line with their reasoning, this paper adopts a reproduction paradigm. It rests on the assumption that “in the social world systems need to be continuously reproduced in order to persist, adapt and evolve.” (ibid, p. 1).

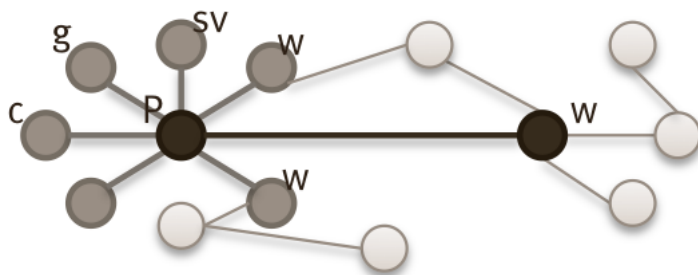


**Figure 3:** Illustration of Dyadic View with pharmacy (P) as focal unit

The subsequent argumentation and later analysis assumes the pharmacy as the focal unit. The reported electronic ordering system can be conceived as a dyadic relationship between a pharmaceutical wholesaler (W) and a pharmacy (P) as depicted in Figure 3. While the perspective focuses on the dyad (coloured in black) its environment remains in the background (grey). The division of labour in this relationship is characterised by the mutually constituting roles of buyer and seller. Each of these roles cannot be thought of without the other. The practices of ordering (or: order placement) and delivery are likewise mutually constituting. Thus, the ordering carried out via the electronic system already presupposes ‘delivery’ as its counterpart. The IOIS is not just an assemblage of technical components; it is a reification of a specific relationship. The alignment of organisations in an IOIS can therefore be understood as a reciprocal adaptation of mutually constituting roles.

By taking into account the dynamics of time and the quest to explain evolution as well as persistence of IOIS, several challenges and shortcomings of such a perspective become evident. A dyadic-view features the study of the division of labour as represented in the mutual constitution of roles. As such an IOIS employs technical objects but is not restricted to them. For instance, pharmacies are able to call the wholesaler in order to make final adjustments to previously sent orders. Thereby, they are able to extend the technical cut-off time until which incoming orders are delivered the same day. This short example already illustrates the brittle nature of the technical linkages that needs amendment of more plastic relations (notion of “brittle” see Reimers & Johnston, 2008). The dyadic perspective allows to study how actors are able to compensate the brittle nature of IOIS. However, it does not explain why an IOIS diffuses in the industry in terms of multiple actors adopting the same solution. Nor does it explain from an individual actor’s point of view like a pharmacy why it should perpetuate the relationship at all or why the ability to direct orders to multiple wholesalers is of importance.

A dyadic view assumes that the roles are not fixed but constantly reproduced. Thus, the question is how mutual adaption in terms of roles and practices takes place. The specific shape of the relationship in this case is not self-evident. Alternatives like vendor-managed inventory (VMI), single sourcing or vertical integration are conceivable and well-known. One research question thus is: Why did this rather non-sophisticated relationship evolve and persist throughout time? If both organisations are in a continuous process of mutual adaptation why did no technical solution emerge that exhibits a higher degree of alignment (e.g. VMI)? Indeed, a more sophisticated relationship may have been expected from a dyadic view. However, in this perspective other relationships move in the background of the analysis. The actor-centric view allows studying such effects.



**Figure 4:** Illustration of Actor-Centric View with pharmacy (p) as focal unit

**Actor-Centric View.** The previous research perspective acknowledges the different roles each organisation assumes in a relationship. Yet, both partners exhibit a fundamental asymmetry. Each organisation maintains relationships with multiple other actors. Due to space restrictions the argumentation as well as the illustrations throughout this paper are pharmacy-focused. Figure 4 entails the former dyadic relation with a wholesaler (black) but enriches the perspective by adding linkages a pharmacy maintains with other actors (dark grey) like patients (C), governmental agencies (G) and software vendors (SV). Moreover, the two other wholesalers (W) come into view.

Relationships not directly linked with the pharmacy are remaining in the background (light grey). Thereby, different potential sources of influence on the IOIS come into view.

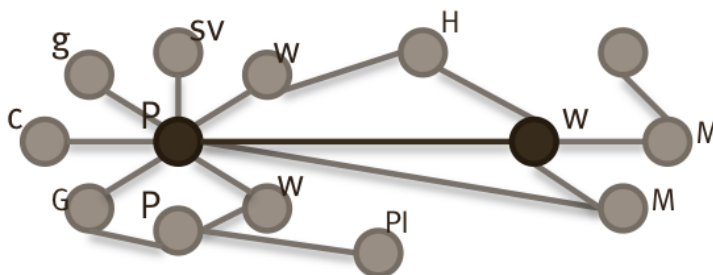
The linkage that constitutes the unit of observation from an IOIS-research perspective is just one among many from a pharmacy's point of view. The sheer number of relationships and the resulting complexity to handle them assigns the IOIS a different meaning. Investments in relationships need to be carefully chosen.

Furthermore, investments in one relationship may lead to repercussions in another. For instance pharmacies provide information and pharmaceuticals to patients. A great portion of their costs needs to be recovered by submitting reimbursement claims to governmental agencies. The interconnectedness of these linkages gives rise to a propagation of effects. For instance a change in the order-delivery pattern may lead to repercussions in the ability of the pharmacy to dispense pharmaceuticals to patients.

Being-a-pharmacist entails a profoundly different world-view than being-a-wholesaler. Pharmacists view themselves primarily as healthcare professionals and only secondary as retailers. The practices in which the IOIS is embedded and with which it connects to are fundamentally different in both organisations. For IOIS research this means that the system acquires a different meaning in each of the organisational contexts. Furthermore, actors in each organisation engage only with a part of the IOIS residing in their organisational context. Thus, parts of the system can be transparent to some actors.

The dyadic view obscured the possibility of pharmacies to maintain similar business relationships with all three wholesalers. They are competitors and provide similar service levels. As such the actor-centric view emphasises the non-exclusivity of the dyad. This constitutes side-effects influencing the IOIS.

The actor-centric view emphasises the asymmetry of business partners. It allows to study the embedding of the IOIS (components) into the practices of individual actors. It accentuates the bounded perception of the actors in regard to the IOIS. By taking into account the interdependencies of other relations each actor maintains, it permits the study of their implications for the evolution of the IOIS.

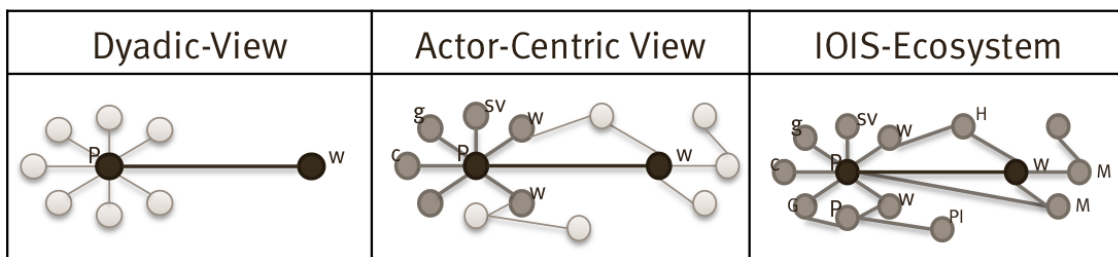


**Figure 5:** Illustration of IOIS Ecosystem View with pharmacy (P) as focal unit

**IOIS Ecosystem.** The IOIS is embedded in a wider environment. The ecosystem view entails the former actor-centric view but enlarges it further by adding remote actors that are not directly related with the pharmacy. In the Australian case the IOIS interconnects 4.700 community pharmacies and three full-line wholesalers. Figure 5 shows additional groups surrounding it (e.g. associations (G), manufacturer (M), hospitals (H), and parallel importers (PI)). As such the ecosystem view features effects emerging outside the interconnections participants of the IOIS have. Furthermore, it highlights – from a pharmacy focused argumentation – the fact that there are multiple (4.700) pharmacies interacting with the wholesalers. The group of pharmacies is not a homogeneous mass of identical actors but can be further differentiated into small chains, banner groups and cooperatives. Despite the three full-line nationwide wholesalers, several smaller short-line wholesalers operate on a regional level.

The ecosystem view allows to study the diffusion of innovations in the environment of the IOIS. Thereby, the proliferation and deliberately set boundaries of the system come to the fore. Remote relationships like for instance between hospital pharmacies and wholesalers may have a potential influence on the IOIS. Innovations may propagate through the network until the IOIS of interest is affected.

In this perspective competing systems and actors attempting to bypass the traditional and established supply chain come into view. The ecosystem view allows tracing the boundaries of the system in terms of its proliferation back in time. This sheds light on the scope of a solution and provides indications for (dis-) incentives to alter or switch the system. Thus, persistence and evolution of IOIS can for instance be studied from a path dependency or network effect point of view. Its proliferation may in addition be an indication of its potential to achieve the status of an infrastructure.



**Figure 6:** Overview of the three perspectives (pharmacy as focal unit)

In conclusion the three aforementioned views are intended as distinct yet related ways to look at the phenomenon. Figure 6 illustrates the different views. The perspectives are geared towards reducing complexity. Thereby, a multi-layered view on alignment can be achieved. They demonstrate that such alignment is multi-faceted. The aforementioned building blocks of IOIS are expressions of such alignment across the three views. The dynamics of alignment unfold over time. Hence, the chosen representation is intended for illustrating the scope of each perspective only.



### 3 IOIS as structurally coupled systems

After giving a brief overview of its origin this section sketches the proposed theoretical concept of ‘structural coupling’ in order to better understand the notion of alignment. This ultimately guides the analysis in which the concept is applied in each perspective. Thereby, both the usability of the perspectives and the benefits of using ‘structural coupling’ on a theoretical level are evaluated.

#### 3.1 Theoretical Concept of Structural Coupling

The concept of ‘structural coupling’ is derived from autopoietic theory (Maturana & Varela, 1980). Autopoiesis was originally devised for the biological domain. Later scholars like for instance Luhmann or Mingers began to discuss its applicability to social systems, which has been contested and is still subject to an extended debate in the literature (see Mingers, 2006 for an overview). A comprehensive introduction to autopoiesis and its implications to ISR can be found in Mingers (2006). Here, we will focus explicitly only on the notion of ‘structural coupling’ and we will draw mainly on the work of Kay (2001) who proposes to use autopoiesis in the social domain. He concedes that social systems are not in themselves autopoietic but they involve and are constituted by processes described in autopoietic theory (ibid, p. 472).

Kay (2001) describes an organisation as a distinct set of interlocked behavioural patterns. Two or more individuals are interacting with each other. The actions of each individual represent a perturbation for the other. Such perturbation may be compensated by the other individual by a change in behaviour which in return represents another perturbation for the interacting partner. As a result both become involved in an ongoing process of mutually compensating behaviours. In Maturana’s terms this brings forth a consensual domain of conduct (Maturana, 1975, p. 323). For an observer such correspondence or adaptation may appear as if an inherent meaning of the actions determines the flow of interaction. However, such functional relations describe structural coupling as a semantic coupling that is as if perturbations would have a determining character (Maturana, 1975, p. 327; Maturana & Varela, 2009, p. 223). Though, such description only pertains to the observer. Over time these mutually compensating behavioural patterns may become distinguished by an observer as an organisation (Kay 2001, p. 473). “The organisation is a description, or in Maturana and Varela’s language, a distinction that allows the individual to distinguish a particular set of recurrent interlocking behaviours from all the other behaviours they may observe. The behaviours take place in the physical space, the description in the non-physical.” (ibid, p. 475). As such the organisation exists as an entity against which individuals orient their behaviour (Kay 2001).

The interactions of interest in IOIS are interactions between organisations. Thus, an observer needs to identify at least two separate sets of interlocked behaviours

(organisations), members of which interact recurrently with each other (IOS). Repeated interactions lead to reciprocally triggered complimentary behaviours. The interactions carried out by individuals become part of the organisations' repertoire and thereby achieve an existence independent of a specific individual. Otherwise such interaction would not achieve a systemic status. Furthermore, both organisations can still be regarded as separate entities.

### **3.2 Specifications as expressions of Structural Coupling**

In the specific case we distinguish two organisations: wholesaler and pharmacy. Over time, both have established patterns of interlocked behaviours. Among these, ordering and delivering are in the focus of this paper. The pharmacist issues an order to the wholesaler. This triggers a compensating behaviour of the wholesaler to prepare and dispatch a delivery to the pharmacy. Furthermore, an invoice is sent from the wholesaler to the pharmacy. This again triggers a compensating action by the pharmacist, which is the payment of the delivered goods. For an observer the order 'causes' a delivery as well as the delivery or invoice 'causes' the payment. This functional relation between one action determining the subsequent action is closely related to the well-known process models in ISR. While this paper does not contest the use of process models in general the notion of structural coupling suggests that such a model pertains to the observer and appears as an impoverished description of the relationship.

If 'order-delivery' is conceived as a consensual domain of conduct, one action only represents a perturbation to the other actor. The "appropriate" response is not determined but dependent on the internal structural dynamic of the entity at that time. In fact this paper argues that in order to understand the characteristics of this pattern of interaction it is necessary to consider the following: (1) interactions with other entities that may impact on the interaction of interest and (2) the perspective or world-view of the interacting partners (e.g. what does it mean being-a-pharmacist).

The aforementioned illustration of structural coupling refers to behavioural coupling. The described instances of interaction rely on material aspects and language as well. What the word 'order' and the message denoted with it means is subject to a process of coordination. Likewise the technological means used for communication are the result of a process of consensual coordination. The partners need to agree on what is regarded as a valid means to transmit orders. On a more detailed level the technological means need specifications. In the exemplary case PDE devices were introduced as a valid means to place orders. The communication between the device and the wholesaler system relied on proprietary specifications. Hence, not all devices were able to 'speak' with each wholesaler system. While this is primarily a 'language' barrier on the technical level it is an indication of a missing coordination or structural coupling between the wholesalers.

This section sketched the original conception of structural coupling and possible application areas for the concept in regard to IOIS-research. It suggests conceiving the order-delivery cycle as a consensual domain. The compensation of perturbations initiated by one of the interacting partners is influenced by the internal dynamics conceptualised as the world-view and perturbations or interactions originating from others. The IOS of interest is only one among many structural couplings a pharmacy has to maintain. The material artefacts and technical specifications or in other words the technical building blocks of an IOIS are conceived as expressions and mechanisms of structural coupling.

## **4 Case Vignettes: Propagation of Perturbations**

In this section the theoretical concept and the developed research perspectives are applied to the case material. The subsequent sections illustrate how this approach can contribute to extend our understanding of the evolution of IOIS.

### **4.1 Dyadic View**

The IOIS of interest was no *creatio ex nihilo*. Instead, it was introduced to an already existing non-automated IOS between pharmacies and wholesalers. In the 1980s both actors relied on telephone communication for coordination of ‘order-delivery’. Electronic ordering and ordering by phone are two interactive patterns observable today. The former can be further differentiated into PDE-based, modem-based (software) and web-based (PharmX) ordering.

The phone ordering is characterised by its high level of interactivity. Both actors need to develop a common understanding of how to identify products unequivocally, how to signal that this ‘call’ is an ‘order’ and how to handle ordering phone calls. After the interaction both are convinced of a found consensus. The buyer thinks to know what the seller will do and vice versa. Yet, the consensus is subject to negotiation in a synchronous way.

Electronic ordering on the other hand does not allow such negotiation to take place in each interaction. Instead, it requires achieving consensus prior to the interactions. Product ID, message structure and communication protocol serve the same purposes as in the phone call situation. Yet, the communication interpreted as a transmission of data remains largely transparent for the actors. As such it represents a brittle arrangement because feedback of success is not instantaneous. It is brittle because it allows only for standardised or better pre-specified events, albeit handling these efficiently. Nothing out of the ordinary can be handled in such a system. The roles and interactive patterns seem frozen.

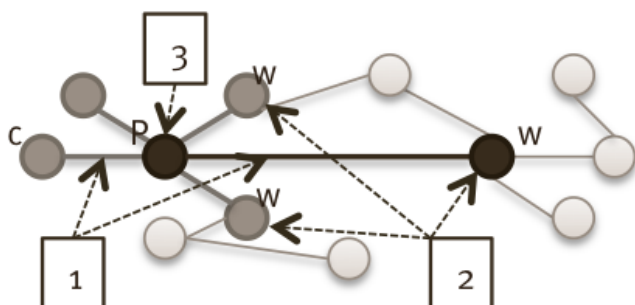
In the specific case the actors compensate this aspect of electronic ordering by not relying solely on electronic ordering. Tele sales staff is still available for phone calls

and would even call pharmacists to remain in constant contact. Furthermore, sales staff would regularly visit pharmacies to maintain the relationship.

The dyadic view leaves several questions open. It does not explain the specific shape of the coupling (e.g. proprietary vs. standardised specifications). Indeed, whether or not a proprietary or standardised solution is chosen, is of no importance in this view. However, the role model is reflected in the technical solution. A VMI would entail different agreed upon specifications than are present in the case. The dyadic view does not point out why modem-ordering is regarded superior while relying on the same mechanism of coupling (proprietary specifications). The diffusion or replication of this mechanism in other relations is not explained as well as the implication of a wide diffusion on the individual relation. These are out of scope of this perspective, which “just” looks at the responses to the mutual perturbations (action – response patterns, operational flow). And lastly, it is incapable to account for the continued existence of this particular relationship over time.

## 4.2 Actor-Centric View

The profession of a pharmacist entails a specific positioning in society. It involves relations and interactions that a wholesaler does not have. The subsequent analysis is based on three illustrating examples depicted in Figure 7: (1) propagation of effects, (2) side effects, and (3) bounded perception.



**Figure 7:** Effects on the IOIS

**1.** Pharmacies aspire a professional relationship with their patients. This implies to have the required medication on stock when the customer asks for it. However, high costs for premises, strict expiry dates, a huge range of products and inability to unilaterally alter prescriptions almost inevitably lead to stock-outs. In such urgent cases, the pharmacist prefers to ring the wholesaler in front of the customer to make sure that the required product is arriving on time. Thus, the pharmacist uses the phone call to signal a professional commitment towards the patient.

**2.** As this view emphasises pharmacies cannot order only from one wholesaler. All three full-line wholesalers offer similar services. The software implements proprietary specifications of all three full-line wholesalers. After receiving an order the wholesaler

responds with a back-list indicating the items that will be delivered in the next run and items that are out of stock. Pharmacists can quickly turn missing items in an order to their secondary wholesaler.

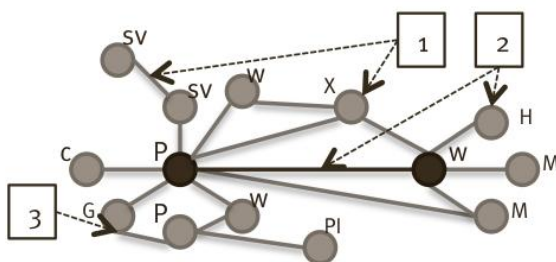
In both cases (1.+2.) the interaction with the patient influences the use of the IOIS. The importance of switching orders does not only become evident in the case of stock outs but represents a power base vis-à-vis the wholesalers. Pharmacists are not locked in to a specific relationship. This represents a side-effect of the competition among wholesalers.

**3.** The third example concerns the invisibility of some parts of the IOIS for pharmacists. In the aforementioned case a common gateway was introduced a few years ago. While that constituted a major change from the software vendors' point of view, the changes are transparent for wholesalers and pharmacists. From a pharmacist's perspective the proprietary specifications of the wholesalers became transparent when POS-systems featuring modem-based ordering entered the market. The ability to route orders to multiple wholesalers resonates well with their practices. In that way software vendors created a quasi-open system. From a pharmacist's point of view both, a fully standardised and a quasi-open system are superior compared to the PDE-system. It is superior because it allows pharmacists to exploit the side-effects of inter-wholesaler competition (e.g. price differences). Whether this reasoning applies to wholesalers and software vendors as well is a different matter.

The actor-centric view explains the persistence of the proprietary specifications as a result of its transparency for the interacting parties. At the same time it underscores the need of pharmacies for at least a quasi-open system. The perspective features a conception of evolution of IOIS that hinges on a propagation of perturbations. Perturbations in other relationships trigger changes in pharmacies which in turn serve as perturbations in their relationship with the wholesalers.

### 4.3 IOIS-ecosystem

The analysis from an ecosystem view is illustrated by four examples. Three of which are depicted in Figure 8.



**Figure 8:** Effects on the IOIS

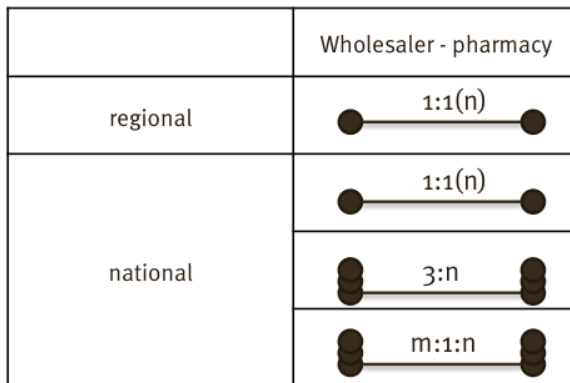
1. By maintaining cost-intensive cross-reference tables the software vendors created a functional equivalent to a standard-based ordering system. While pharmacists enjoy the benefits of a quasi-open system and the wholesalers continue to receive orders from the entire market, the software vendors have an incentive to overcome the proprietary specifications. Consequently, several initiatives were launched. The ultimately successful establishment of the PharmX-gateway (X) did not fulfil this intention. However, the ordering gateway institutionalised as an outcome of a joint venture of the software vendors represents a new stage in the evolution of the IOIS as it builds upon the wide diffusion of broadband among pharmacies. The emergence of innovations outside the IOIS and its direct environment represents the strength of the ecosystem view.

2. Wholesalers do not only deliver to community pharmacies but supply hospital pharmacies (H) as well. The introduction of web shops to the pharmacy sector is an outcome of this relationship. From a pharmacists perspective it represents a new coupling with the wholesaler. Thus, the coupling with the hospitals served as a blueprint for an innovation in the IOIS.

3. Similar to the PharmX-initiative, associations often play a major role during the emergence of IOIS. In the Australian case the representative body of the pharmacists (G) did not intervene when PDE-devices based on proprietary standards were introduced. However, in a similar case (Klein, Schellhammer, 2011) such association used its close relationship with pharmacies to influence the wholesalers' decisions regarding the IOIS.

4. On the level of the ecosystem it is possible to show how the system morphed through several stages. Figure 9 depicts the stages that are described in the next paragraph.

In the 1980s the wholesale market of pharmaceutical products was characterised by smaller suppliers with a strong regional focus. One explanation of the emergence of proprietary specifications rests on the scope of the market for the wholesalers at the time. If the relevant market for an IOIS is conceived as regional a nationwide solution including the necessary coordination is out of scope for wholesalers. Later due to mergers and acquisitions the wholesalers evolved to nationwide suppliers. At this stage the proprietary specifications were already in place. As such the modem-based ordering overcame the relict of regional markets expressed in the PDE-device. Yet, the device was not directly disposed and would in principle work nationwide as well. The modem-based software allowed routing the orders to multiple wholesalers and thereby opened new customers for the now nationwide operating wholesalers. The PharmX initiative did not overcome the proprietary specifications but opened up the electronic ordering channel to smaller suppliers as well. Thereby, the scale of the IOIS is enlarged again.



**Figure 9:** Development stages of IOIS in ecosystem view

The persistence of the proprietary specifications is explained in this view by the wide proliferation in the industry. Wholesalers maintain connections with several thousand customers. A widely employed technical solution is therefore not easily changed. Until the very day wholesalers need to maintain modem-connection which today would be regarded as legacy systems. In that way the installed base of old technology represents a severe disincentive for innovation in the coupling mechanism.

## 5 Discussion

The study of IOIS over large timescales poses severe challenges to research models. In order to account for the evolution of an IOIS an appropriately large unit of analysis is required. Under such circumstances the complexity of the phenomenon exacerbates considerably and renders traditional approaches useless (cf. Reimers, Johnston, & Klein, 2010). Therefore, the paper started out to devise three perspectives on the phenomenon that exclude to varying extent contextual factors. The dyadic view in this sense represents the most basic perspective. Traditional approaches like transaction cost economics operate on this layer. However, transactions are embedded in a wider environment. This paper argues that dyads are nested in the actor-centric as well as the ecosystem view. Their influence overshadows the developments of the dyadic view. Each perspective features a different facet of the ‘alignment’ organisations venture in an IOIS. As such the perspectives complement each other in structuring the analysis.

‘Structural coupling’ is proposed as a theoretical conceptualisation of ‘alignment’. It emphasises the autonomy of the organisations. It does not presume the environment or the organisations to be fixed. Perturbations do not determine the reaction but need to be considered as triggers that may lead to structural changes. The IOIS under scrutiny is a manifestation of such structural coupling between pharmacy and wholesaler. However, it exists among various kinds of structural couplings. Each of the developed perspectives brings forth a different form and facet of structural coupling of which the previous section provided anecdotal evidence.

In the dyadic view only one respectively two sources of perturbations are present. The structural coupling manifests in the mutual adaptation of order-delivery practices. Various forms of technical mechanisms are conceivable to support such relationship. While the technical solution reflects the emerging form of the division of labour, the dyadic view falls short on explaining why an individualised solution has not emerged.

The actor-centric view accentuates the particular worldview of the organisations. Perturbations may arise from multiple sources. The focal entity needs to manage the degree and form of structural coupling to multiple entities. The structural couplings represent a network portfolio configuration the entity maintains. Internally this may be described as a balancing act. The specificity of mechanisms of structural coupling like the proprietary specifications is increasing the complexity.

The ecosystem view includes perturbations arising from remote sources into the analysis. Furthermore, the extent of the proliferation of the IOIS becomes visible. In that way structural coupling is studied as the development of an infrastructure on which other structural couplings may build.

In that way ‘structural coupling’ represents a theoretical concept that can be employed on each of the proposed perspectives to elicit different facets of ‘alignment’. In doing so different facets of the identity of IOIS come to the fore. Change and persistence of the IOIS are associated to different forms of structural coupling. The managerial relevance of such a perspective is yet to be explored. From this point of view specifications as instances of structural coupling can be seen as investments in a specific relationship. As the different views show such investments may be interpreted differently by the partners of an IOIS.

## **6 Conclusion**

The paper is motivated by the question how to conceptualise the mutual alignment of organisations in an IOIS over large timescales. The complexity of the phenomenon under scrutiny lead to the development of three research views promising insights into aspects of the evolution of IOIS. The notion of structural coupling was proposed as a means to conceptualise such alignment along all three perspectives. While an evaluation of the concept at length in this paper was impossible, anecdotal evidence – assuming a pharmacy as a focal unit - suggests it as promising venue. Future research needs to systematically test as well as refine the proposed concepts by applying it to empirical data. Thereby, the analytical and explanatory power of structural coupling for explaining the dynamics of alignment over large timescales can be examined.



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