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Theory-based Analyses of Interorganisational Standards for Self-organising, Adaptive Value Creation Networks

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Abstract: Today many enterprises find themselves in situations of forming new or integrating into existing value creation networks to strengthen their market position and to provide new innovative customer solutions to its customers. Due to their high complexity, effective and efficient value creation networks rely on self-organising and adaptive structures and processes. Information flows amongst business partners and the coordination of these flows by cooperation activities are major design parameters of such networks. Interorganisational standards (IOS) seek to ease information infrastructure design by providing a referential frame. However, practitioners finding themselves in situations of selecting specific standards and thereby deciding against others, so far lack sufficient theoretical guidance in this selection problem. This research informs the IOS selection problem by condensing insights from the body of knowledge from management cybernetics and coordination theory and identifying first requirements to a method guiding IOS choices.

Keywords: Interorganisational Standards, Self-Organisation, Adaptivity, Value Creation Networks, Autopoiesis

1 Motivation

Boundaries of nowadays organisations shift from structures and processes of single companies to value creating networks, which are not designed and implemented by a central instance but that instead emerge cooperatively in negotiation processes. These networks can be viewed on as self-organizing systems which rely on IT to coordinate cooperation amongst network actors through communication when digitizing business relationships (Salo 2006).
In business relationship digitization interorganisational standards are a means to assuring a vocabulary that is widely understood to negotiate for and perform business transactions within such systems –and thereby allowing for business interoperability (Green et al. 2007). IOS provide a corpus for converting data into an agreed syntax (i.e. a grammar) (Philip and Petersen 1997). Upon this corpus exchange processes aim at (1) directing data to and gathering data from different application programs, (2) converting data from proprietary formats (as used by application programs) to standard formats (as transmitted by the communication network) and reversing the process at the other hand and (3) the actual transmission of data between network actors over a communication network.

We more precisely aim at the analyses of semantic and process standards to support such cooperation. With respect to Löwer (2006) we define IOS as follows:

> *"Interorganisational standards are broadly adopted specifications that formally define or support business-related semantics and processes, which are made accessible to other organisations' information systems [...]."*

Amongst the various architectural choices in the design of the digital network infrastructure, this work is concerned with the selection of a "good" standard (set) when having several appropriate ones on hand. So far there exist several studies analysing the adoption and implementation of specific IOS. Elgarah et al. (2005) for example present a review of 68 articles from the academic fields of (Management) Information Systems, Logistics, Production, Management Science and General Management.
In contrast, there is little literature analyzing the IOS selection problem that is selecting an appropriate IOS standard when having several rival standards at hand. Related work builds up on insights from technical grammar evaluation and is limited to independent mostly ontology-based analyses of IOS standards (cp. Green et al. 2005).
Here, we argue for a broader understanding of what actually a "good" standard is. We therefore utilize insights from the body of knowledge in Management Cybernetics and Coordination Theory as theoretical lenses to network effects in the value creation network induced by the business relationship digitization related to the IOS selection decision.

Accordingly, this research seeks to explore: Which are distinctive requirements exhibited by applying these lenses to the IOS decision problem?

The remainder of this paper is as follows: Sec. 2 explains and structures the different standards appertaining to IOS. Sec. 3 discusses the role of IOS in adaptive, self-organizing value creation networks. Then in Sec. 4, theories from Management Cybernetics and Coordination Theory are applied to the IOS selection problem for deriving distinctive requirements that shall inform a method guiding the selection process. Sec. 5 foreshadows how these insights will be imbedded in our future work. Sec. 6 provides a conclusion.

2 A structuring of the IOS domain

According to the International Organisation for Standardisation (ISO/IEC 1996) a standard is a "document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context." This definition can be decomposed into separated standard characteristics. Firstly, its explication in a document, including also digital ones, is crucial to prevent ambiguity. Secondly, standards can be 'de jure' nature, i.e. defined and enforced by governmental organisations, or 'de facto', i.e. emerged through voluntary development and adoption (Antonelli 1994). Thirdly, standards can have different objects they refer to, e.g. activities and results. According to Timmermans and Berg (1997) activity standardisation can be related to process standards, defining the coordination and execution of certain activities. One example of such standard is RosettaNet' Partner Interface Processes (PIPs), which among others defines business data entities and their flow of exchange between roles (RosettaNet 2004). Alternatively, standardization may target product in that they define properties and functions of physical or digital goods.
Semantic standards describe the meaning of terms unambiguously. EDIFACT is a common example for this kind of standards defining business documents with precisely defined data

fields. Finally performance standards define the outcome level of a product or process which relies on quantitative, measurable criteria.

Löwer (2006) structures the semantic and process standards in a standards' stack (cf. figure 1) to identify different levels of concern that will be subject to our further analyses. The stack consists of three basic layers: technical, universal and sectoral standards. Technical standards facilitate the basic technical communication of information systems. It encompasses messaging standards, such as SOAP, description standards of software services, such as web service descriptions in WSDL and discovery standards to retrieve technical services, such as UDDI. The universal standard layer is, in analogy to the formerly made distinction, horizontally divided into a semantic and a process standard part.

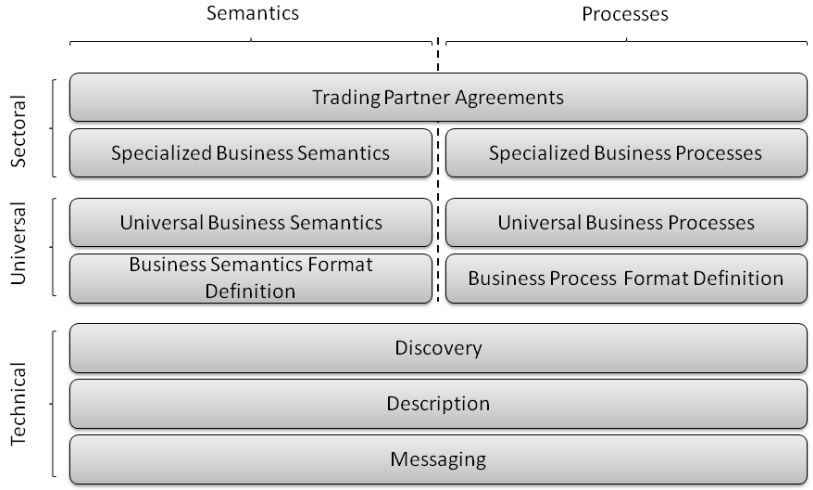

Figure 1: Stack for interorganisational standards (based on Löwer (2006))

Horizontally the lower layer refers to standards that define formats for the specification of business semantics and business processes. The formats themselves can be divided into semi-formal modeling approaches –such as BPMN or UMM/CEFACT– or formal, executable formats – such as BPEL or ebBPSS. These formats are then used in the next layer to define actual business semantics and processes that interorganisational scenarios can directly draw on (Löwer 2006). They are generic in the sense, that they are applicable in different business scenarios. One representative is the industry-independent CPFR standard for collaborative forecasting processes. The sectoral layer defines standards that fulfil the specific needs of different industries. They base on the layer of universal standards but incorporate industry specific processes and semantics. One example for an industry dependent standard is RosettaNet providing collaborative forecasting PIPs, which are based on CPFR but fulfil specific needs of the electronic industry.
The stack's top layer contains the trading partner agreements (TPA) standards. They facilitate the definition of trading agreements among organisations by documenting all relevant details of a cooperation contract including technical as well as organisational and legal details. Thus the focus of these standards is the initiation and negotiation of downstream cooperative transaction execution. Within this layer the overall architecture of standards that defines the

interplay of the various standard components comes into play. An example for a standard for trading agreements is the ebXML Collaboration Protocol Profile and Agreement (ebCPPA) specification. It documents the technical details of the technical coupling of collaboration partners on the basis of partner profiles that beforehand were published in central registry.

3 IOS in adaptive, self-organizing value creation networks

Self-organizing value creation networks can be considered as an autopoietic system (Varela et al. 1974). Autopoietic systems are described by theories of living systems that reproduce recursively and thereby create and maintain themselves. To assure their viability, such systems have to adapt to their constantly changing environment. In the discipline of Management Cybernetics much research has been conducted inquiring the viability of systems (i.e. Beer 1972, Espejo & Schwaninger 1993). Moreover, autopoietic systems are self-referential and accordingly can be delimitated from their environment. At the same time autopoietic systems depend on their environment and therefore cooperate in networks that emerge from structural couplings (Luhmann 1987). Zeleny (2001) applied this theoretical perspective to small and medium enterprise networks and so contributes to the understanding of the dynamics of such networks. From such autopoietic perspective, IOS facilitates structural coupling of different actors in a value creation network. First, they allow for basic communication mechanisms and, on top of this, they support advanced cooperation processes. Secondly, IOS facilitate the overall viability of the autopoietic systems as they allow for more easily and flexible building up new network structures.
Substantial previous research has inquired the nature of self-organizing systems and identified design parameters for successfully building such organisational systems. Within the next section we take the theoretical perspectives of Management Cybernetics models and Coordination Theory as sensitising devices for more concretely elaborating requirements to the IOS selection problem from an organizational point of view.

4 Theoretical lenses to the evaluation of standards

We argue that the “goodness” of a standard in an IOS selection decision can’t be solely estimated by an analysis of its internal structure. Instead, such decision must be in-line with (amongst others) strategic goals and plans of the enterprise. This decision also has to consider the dynamics of the surrounding business settings. In practice, digital business relationships are often built up gradually from one time-limited contact between organizations to often very close, far-reaching exchange relationships. These relationships are in a constant state of flux (Salo 2006).
Body of knowledge in organisation, communication and management sciences contributes significant insights that can serve as theoretical lenses for understanding these dependencies amongst network actors and how the IOS selection affects the business relationships. Requirements derived from these theories broaden the understanding of what a “good” standard is to practitioners in the IOS selection problem.

4.1 Viability and Development from the viewpoint of Management Cybernetics
Referring to Schwaninger (2001) organisations shall strive for viability in the sense of development as a permanent process of self-renewal. He conceives the implementation of the

principle of “continuity through discontinuity” in four basic faculties of the so-called intelligent organisation: (1) adaption as change in respond to external stimuli, (2) ability to influence and shape their environment, (3) to find a new milieu or reconfigure themselves with their environment and (4) to contribute to the development of the larger wholes they are embedded in. Schwaninger’s Framework of Intelligent Organisations structures organisations into five dimensions that have to be impacted simultaneously to assure their viability and development. The first three dimensions –activities, structure and behaviour– refer to the St. Gallen Management concept (cf. Bleicher 1999) and are complemented by the essential parameters ethos, identity and vision (presented as one dimension) and the dimension of time. In the tradition of the systems approach to management research, three models are introduced and integrated as a comprehensive instrument for organisational change: (1) the Model of Systemic Control (MSC), (2) the Viable System Model (VSM) and (3) the Team Syntegrity Model (TSM).

Here, we limit our analysis to exploring the explanatory power of MSC and VSM in an IOS selection problem due to the following reasons: In the context of MSC we analyse how IOS impact and are impacted by the various scopes of management, namely the three logical levels of management. In the context of the VSM we seek to identify which structural communication channels existing in the organisational structure shall be supported by IOS and in which way this support shall be realized.

Reciprocal impacts between IOS and aspects of various management scopes
Management Cybernetics conceives management in terms of coping with complexity. The approach of the MSC to deal with this complexity is to govern an organisational system by means of control variables that belong to different logical levels of management: the operative, strategic and normative level (Schwaninger 1989). As indicated in figure 2, higher levels of management relate to lower levels as they define pre-conditions. Schwaninger uses the term pre-control of variables to verbalise this relation.

On the operative level, the overall goal is to create value e.g. in terms of customer benefit, cash flow and social benefit. The directive is to operate efficiently for realizing attained goals. Electronic communication in B2X scenarios could contribute remarkably to realizing more efficient coordination in value networks than e.g. paper-based communication could do. Nevertheless one has to consider which aspects of value creation can be impacted by standards. One direct impact is the contribution of B2C technologies to customer benefit via standardised purchase scenarios including product catalogue and payment standards. Another aspect is the indirect value creation through cost reduction in B2B communication scenarios by applying order processing or shipping standards.

Req. 1: On an operative level of management the contribution of IOS to value creation has to be defined with respect to control variables.

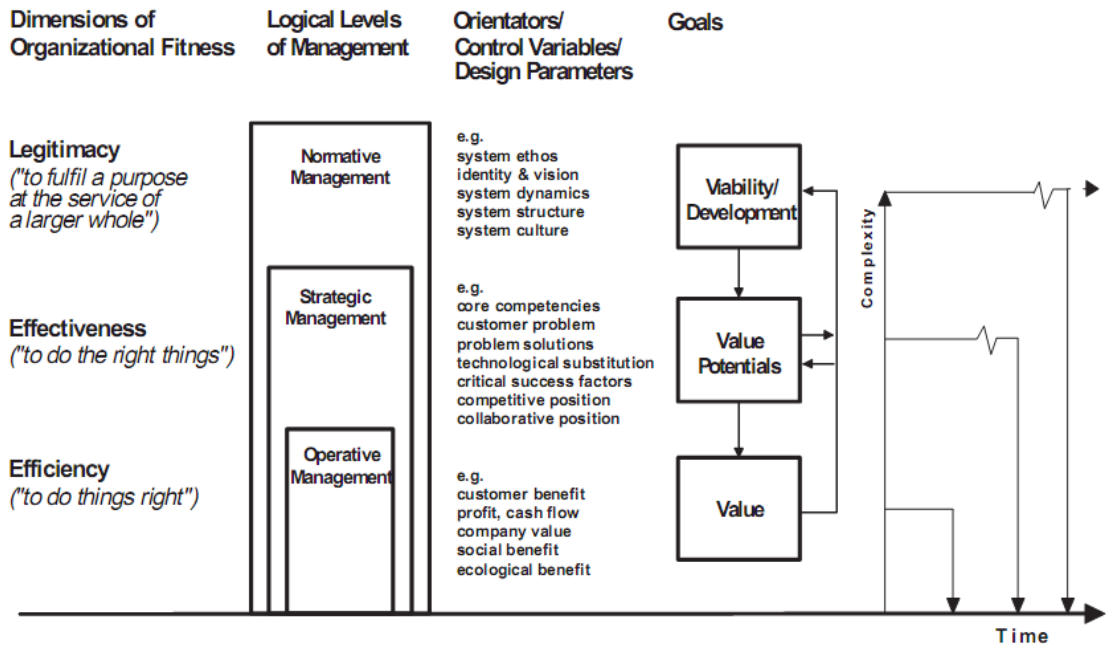

Figure 2: A model of systemic control (Schwaninger 2001)

We argue that a company's decision for an IOS is more than the selection of a technology for the purpose of interorganisational communication and the achievement of short term revenues (or losses). We illustrate such effects by introducing two scenarios where IOS have direct impact on the organisation's competitive and collaborative position. First, the adoption of a domain specific standard is a strategic choice which integrates the company into a specific network of suppliers and consumers but at the same time excludes it from other networks. The same holds for domain independent standards that facilitate communication with a network using the same and hamper if not impede the communication with other networks. Secondly, the context of cooperation bears a huge potential for enriching an organisation's capabilities. It can strengthen its market position if being an Obligatory Passage Point. This term resides from Actor Network Theory (ANT) and refers to the competitive position of an actor within a network as a gatekeeper as it claims control of crucial resources and responsibility for the success of an emerging actor-network (Martin 2000).

Both scenarios outline the strategic impact of the choice of IOS and position the preceding decision at the strategic level of management. Here the criterion for organisational fitness is effectiveness, both in competitive and cooperative sense (Schwaninger 1989). At this stage value potentials are defined as a prerequisite for the realisation of values on the operative level.

Req. 2: The strategic impacts in the sense of possible value potential have to be considered when selecting an IOS.

The normative level of management is concerned with the overall goal of guaranteeing viability of an organisation. Schwaninger (2001) takes a distinctive view on this capability:

"Intelligent organizations conceive their viability in a broader way in the sense of mere survival at any price, or of autopoiesis, i.e. self-reproduction. Ultimately, they adhere the goal of development."

Development in the understanding of Ackoff (1994) is defined as a system's growing ability and desire to fulfil its own and others needs. The normative management level is concerned with the organisational aspects of identity, ethos and vision. In Schwaninger's integrated view these are considered as fundamental parameters that influence the other dimensions, which are activity, structure and behaviour. Identity is what makes an organisation unique and distinguishable from its environment. The ethos consists of the salient ethical principles or the characteristic spirit of an organisation. A vision can be understood as a highly imaginative anticipation of the possible future of an organisation (Schwaninger 2000).

Req 3: The choice of an IOS has to be made in accordance with the organisation's identity, ethos and vision.

Requirements derived from structural normatives to viable systems
The VSM is a normative model that predefines an organisation's structure that is necessary and sufficient for its viability (Beer 1972). The structure consists of five different systems each fulfilling a specific function and demanding predefined communication channels amongst these systems. In the context of value networks we assume that the different divisions controlled by system 1 to 5 or even systems themselves are partly or completely distributed and logically or geographically dispersed in different organisations, such as sub-departments or independent business entities. This constitutes the overall requirement to IOS.

Req. 4: IOS have to purposefully integrate all VSM system components in providing standardized communication channels amongst them.

Each division is controlled by an own system 1 in the manner of a closed-loop control, more specifically a servo mechanism (Beer 1972). In this constellation control is implemented by means of a model of the division. An important aspect of such models are indicators that are eligible to measure the status of the division. In terms of these indices, target values for the divisions are defined, activities to achieve them are triggered and results und environmental influences are perceived by sensors. In case of deviations, i.e. differences in target and observed values, adjusting activities have to be triggered. These servo mechanisms are implemented by controlling departments in most medium and large enterprises. Reporting plans and triggering events are subject to standardisation.

Req. 5: IOS have to define standardized reports on the basis of indices to facilitate the control of operational divisions.
Req. 6: IOS have to facilitate the triggering of operational activities of divisions.

System 2 has the function to prevent uncontrolled oscillations of the various divisions. It therefore has communication channels to all regulatory centres of the divisions and has to coordinate their activities with the help of provided information. An example for such oscillation is the Bullwhip effect that occurs in supply chains of producing companies (Lee et

al. 1997). Here, the lack of information on customer effects leads to oscillations in order quantities that infer to the upstream supplier side.

Req. 7: IOS have to facilitate information sharing with the operational divisions of a network to facilitate their coordination and to prevent oscillations.

System 2 assures coordinated activities among all divisions. However it cannot assure an overall optimum of the operations, thus synergy between the scattered divisions is achieved. This is the function of system 3. Its task is to define an overall plan for resource allocation considering all information provided by system 4 and 5. Moreover the allocated resources have to be controlled in their purposeful application. Therefore the resulting requirements to IOS are twofold.

Req. 8: IOS have to facilitate a standardized definition of resource allocation plans for the purpose of an overall optimal resource planning for the entire system.
Req. 9: IOS have to facilitate a standardized control of data exchange on operational resource consumption.

After deriving requirements from the viewpoint of distinct models of management cybernetics we now want to focus on coordination aspects of IOS.

4.2 The contribution of standards to support interorganisational cooperation
Organisations have to coordinate their activities in order to facilitate business cooperation. Coordination processes rely on a standardized communication vocabulary the cooperation partners agreed upon. IOS play a crucial role in providing such vocabulary. However, in order to evaluate the contribution standards *have* to make to the coordination of organisations it is indispensible to first identify which contribution they possibly *can* make. For answer this question, we here refer to coordination theory as a sensitizing device. Malone and Crowston (1994) define coordination as the management of dependencies among activities. This management function can be facilitated through coordination processes. This leads to a first general requirement to IOS.

Req. 10: IOS have to facilitate coordination processes supporting the management of dependencies among activities.

In order to substantiate this requirement the term of dependencies has to be illuminated. Malone and Crowston (1994) distinguish seven types of dependencies but emphasize that this list is by no means intended to be exhaustive. Analysing different disciplines, i.e. Computer Science, Economics, Operations Research and Management Science, all of which are confronted with these kinds of dependency problems, they identify various coordination processes to manage them. We here want to elicit two types of dependencies which can be directly related to IOS. First, there is the producer/consumer relationship dependency. In this dependency the consumer of information provided by a producer is dependent on the applicability of this information. One way to manage this dependency is to standardize, i.e. to uniform, the semantics of this information in a way that is expected by the consumer.

Req. 11: IOS have to contribute to the standardisation of the semantics of information in information producer and consumer relationships.

Another major dependency is the one of shared resources. Here activities (or their performers) vie with each other for limited resources such as staff capacity, material resources or information. One process to manage this dependency are market-like bidding processes. Another possibility is the implementation of waiting queue mechanisms such as "first come first server (FCFS)" or "lowest operation time first serve". Appropriate processes have to be identified and supported by IOS.

Req. 12: IOS have to facilitate for flexible adaptation of coordination processes for addressing resource dependencies.

Coordination processes themselves consume resources. The efficiency of coordination processes is of paramount interest to judge their adequacy and applicability in a business context. One approach to such analysis is described by transaction cost theory (Williamson 1975).

Req. 13: IOS have to support the implementation of efficient coordination processes in value creation networks.

4.3 Summary of Requirements

All aforementioned requirements are subsumed within table 1. Findings are organised referring to the theoretical lenses that led to their identification.

Model of Systemic Control (MSC)	
Req. 1	On an operative level of management the contribution of IOS to value creation has to be defined with respect to control variables
Req. 2	The strategic impacts in the sense of possible value potential have to be considered in the choice of an IOS
Req. 3	The choice of an IOS has to be made in accordance with the organisation's identity, ethos and vision
Viable System Model (VSM)	
Req. 4	IOS have to purposefully integrate all VSM system components in providing standardized communication channels among them
Req. 5	IOS have to define standardized reports on the basis of indices to facilitate the control of operational divisions
Req. 6	IOS have to facilitate the triggering of operational activities of divisions
Req. 7	IOS have to provide information about the operational divisions of a network to facilitate their coordination and prevent oscillations
Req. 8	IOS have to facilitate a standardized definition of resource allocation plans for the purpose of an overall optimal resource planning for the whole system
Req. 9	IOS have to facilitate a standardized control of data exchange on operational resource consumption
Coordination Theory	
Req. 10	IOS have to facilitate coordination processes supporting the management of

	dependencies among activities.
Req. 11	IOS have to contribute to the standardisation of the semantics of information in information producer and consumer relationships
Req. 12	IOS have to facilitate flexible adaptation of coordination processes for resource dependencies
Req. 13	IOS have to facilitate efficient coordination processes

Table 1: Summarized table of requirements

5 Guiding the IOS selection process in value creation networks

Future research of the authors strives for developing a methodology that guides the IOS selection problem of specific enterprises finding themselves in the situation of either setting-up new value creation network participation or redesigning yet established cooperation. Therefore we are going to inquire Brazilian-German transnational business cooperations. This paper serves as a first theoretical basis for standards' evaluation and structuring of the considered application domain. Future research subsequently aims to validate and extend stated requirements by qualitative empirical studies in Brazilian-German value creation networks in several different industry contexts. After a categorisation and extensible analyses of existing IOS we then will integrate these insights within a decision support methodology. Afterwards this methodology will be implemented in a software tool to ease its practical application. The method will be evaluated both with expert revisions of IOS recommendations made for specific cooperation scenarios and with a standard's implementation setting in a real world cooperation scenario.
Our research design follows the design science approach where artefacts are created (decision support method) and evaluated (expert revisions, implementation evaluation) (Hevner et al. 2004, March & Smith 1995). Evaluation results will continuously be fed back by aligning the method.

6 Conclusion and Outlook

This paper outlines our ideas towards a more comprehensive understanding of "good" IOS by their contribution to self-organizing and adaptivity in scenarios of value creation network cooperation. Therefore, this work identifies distinct requirements to IOS that were derived through the application of the theoretical lenses of management cybernetics models and coordination theory. There are further theoretical underpinnings of the domain that might be appropriate for this purpose and that will be drawn upon in our future work, which strives to complement the catalogue of requirements as presented here.

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