A Model for Semantic IS Standards[1]

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Abstract

We argue that, in order to suggest improvements of any kind to semantic information system (IS) standards, better understanding of the conceptual structure of semantic IS standard is required. This study develops a model for semantic IS standard, based on literature and expert knowledge. The model is validated by case descriptions of two particular semantic IS standards. The model shows characteristics of semantic IS standards. Some of these characteristics might become steering factors for improving the development, adoption and quality of standards, among others.

1 Introduction

Many studies have been devoted to the diffusion of semantic standards (Boh, Soh, & Yeo, 2007; Markus, Steinfield, Wigand, & Minton, 2006; Zhu, Kraemer, Gurbaxani, & Xu, 2006), often seen as problematic. Others focus on the development process (Zhao, Xia, & Shaw, 2005) of semantic IS standards. Still, few have given explicit structure to what a semantic standard actually is. Judging by available case studies and mutual comparisons, we know they are quite different. For instance, case studies of RosettaNet and MISMO reveal that development and diffusion tactics are case-specific and need to be adjusted for each semantic IS standards based on its (internal and external) characteristics (Boh et al., 2007; Markus et al., 2006). This implies the need for a basic understanding of the situation and characteristics of semantic IS standards, in order to be able to effectively manage and influence the important and difficult processes of standards development and adoption.

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Although classifications of standards exist (eg. (De Vries, 2006)), still semantic IS standards is not part of current classifications. Different terms and definitions are used for semantic IS standards. In the standards area, setting up a definition seems impossible since every author uses a different one, but it is also less relevant if we can describe a semantic standard by a set of characteristics or model. This research starts with an analysis of current definitions and continues with the construction of the model of a semantic IS standard. By having this model other new additional studies will be able to pinpoint specific improvements based on the characteristics of a specific semantic IS standard. These improvements might be aimed at different goals like the speed of development, diffusion, or the quality of the semantic standard.

2 Research approach

The main research question for this study is: What constitutes a semantic IS standard? This question is answered by designing a model of semantic IS standards, according to the following design science approach (building an "artefact", the model), including build and evaluate phases (Hevner, March, Park, & Ram, 2004):

1. Definition

   Proposing a semantic IS standard definition based on current literature.

2. Development of the model

   The model is iteratively constructed in multiple expert sessions, combined with searching for fundaments in literature including the Development and Management model of Open Standards: BOMOS (www.noiv.nl/bomos)

3. Validation model by Explorative Case study: SETU

   When developing an artifact you have to demonstrate it works (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007), which is done by describing the semantic IS standard named SETU in terms of the model.

4. Validation model by Multiple Case Study: XCRI

   A second validation was performed by having multiple groups of students describe the XCRI standard; half of the groups used the model, the other half did without.

5. Further research & Conclusions

   The concluding section revisits the research question and presents suggestions for further research.

In general this research adds knowledge about the complex notion of a semantic IS standard. This is much needed for further improvements in this area, and not ready present in current literature.

3 Defining Semantic IS Standards

The term Vertical Industry Standards (VIS) (Markus et al., 2006; Steinfield, Wigand, Markus, & Minton, 2007) is an often used synonym for semantic IS standards, but excludes horizontal standards and government-related standards. The term Business Transactions standards (Rukanova, 2005) excludes document standards, and open Inter-Organizational Systems standards (Zhu et al., 2006) excludes proprietary standards but includes technical standards. Many more definitions exist, also on higher abstraction levels: a standard which is abstract and focuses on a taxonomy of terms, it is usually called an ontology and used as controlled vocabularies according to (Bernstein & Haas, 2008).

We use the definition of VIS standard, but have adapted it to accommodate horizontal (cross-industry) standards and government-related standards: “Semantic IS standards are designed to promote communication and coordination among organizations; such standards may address product identification, data definitions, business document layout, and/or business process sequences.” Adapted from (Steinfield et al., 2007)

That semantic IS standards differ from other standards (like IT Product standards) is widely acclaimed. For instance Zhao mentions (Zhao et al., 2005):

- Standard Developer is the SDO (no IT vendors)
- SDO are industry fora (not the traditional formal SDOs)
- The “user” of the standard is the implementer.
- No direct competition among adopters.
- No significant IPR issues.
- Scope is dynamic.

Although our research might be applicable to other types of standards, this is not the scope of our research and therefore remains an open question.

4 Model of a Semantic IS Standard: The design process

The design process consisted of three steps:

1. Expert sessions in setting up the model.
2. Finding literature that can be used for grounding.
3. Grounding and finalizing model.

In the first step, six experts, involved in multiple semantic IS standards, were consulted in multiple brainstorm sessions. During these sessions, first versions of the model were constructed and enhanced

In the next phase we looked for literature that might support or augment the model choices made so far. The starting point was a list of 43 papers indentified in a structured literature

review in top IS and Management Journals (Folmer, Berends, Oude Luttighuis, & Van Hillegersberg, 2009). Due to their relevance to the issue nine studies in a special issue of Electronic Markets on "Vertical Industry Information Technology Standards and Standardization" were added. From these 52 studies, a selection based on the subject being a semantic standard, was made of six studies to be used for this purpose.

Three of these papers (Boh et al., 2007; Zhao, Xia, & Shaw, 2007; Zhu et al., 2006) have been analyzed, but contained only a minimum number of concepts, which are also present in the other studies and were therefore redundant.

This left us with three studies containing suggestions for what constitutes a semantic IS standard. Most promising is the first study (Nelson, Shaw, & Qualls, 2005), the only available comparison of nine semantic IS standards. The second study (Zhao et al., 2005) addresses multiple semantic standards, in order to design a development cycle. Finally, the MISMO case (Markus et al., 2006), although being an individual case study, provided valuable detail as well. This leads to following list:

1. Interorganizational System Standards Development in Vertical Industries (Nelson et al., 2005)
2. Vertical E-Business Standards and Standards Developing Organizations: A Conceptual Framework (Zhao et al., 2005)
3. Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage Industry (Markus et al., 2006)

The third step consisted of going through the studies and finding traces of elements of a semantic IS standard, and mapping these traces on the developed model. By using these three papers we were able to find traces of almost all concepts in the model, however often not very elaborate.

5 Model of a Semantic IS Standard

Our model of a semantic IS standard consists of three hierarchical layers. On the first layer a Semantic IS Standard has a context, contents, development & management, and appliance. Definitions are presented in the following table, as well as literature references (the number represents the previous list) and some insights from literature when available.

Nr.	Item	Definition	Literature	Remarks
A.	Context	The environment of the standard	1,2,3	Mainly focused on the organizational domain; less on the problem domain.
B.	Contents	The solution that the standard offers (the content of the standard)	1,2,3	For this subject the references in literature are scarce.

C	Development & Management	The aspects related to the development and (ongoing) management of a standard.	1,2,3	Well present in literate, but not really balanced (e.g. much focus on certain aspects like Rights Policy)
D	Appliance	Aspects related to the implementation and use of the standard	1,2,3	At high level well present in literature, however the lowest level concepts are very scarcely mentioned.

Table 1 – High level constructs in the model of a semantic IS standard.

It shows that a standard has its context (Part A): an environment in which stakeholders have a certain interoperability challenge for which a solution is required. The actual solution, its contents, is the second part (Part B) of the standard, and what many will see as the core of the standard. However, each standard is developed, and some are managed, and all other related part to the standards organization characteristics are the third part (Part C) of the standard. All aspects related to the (potential) use of the standard are part of the fourth and final appliance section (Part D).

These four concepts are further decomposed in the next two layers. We start with the decomposition of the context of the standard.

Nr.	Item	Definition	Literature	Remarks
A.A.	**Organisational domain**	**Actors and stakeholders related to the standard**	**1,2,3**	
1	Targeted Audience	The audience where the standard is intended for.	1,2,3	
2	Adopted Audience	The audience that uses the standard.	1,2,3	
3	Active Community	Actors that are actively participating within the community of the standard.	1,2,3	Focus on different types of stakeholders present in the active community
A.B.	**Problem domain**	**The context of the problem for which the standard is designed.**	**1,2,3**	
4	The problem (goals)	Description of the real life problem used as goal for designing a solution.	1,3	
5	Application domain	Descriptions including relations about the domain of the intended solution, including rules that will be constraints for the design like laws or other kind of rules.	2,3	The scope of the setting.
6	Business case	The business case expressing the costs related to the problem in relation to the costs of the solution.	1,2	

Table 2 – Detailed elements of the context.

Arguably most important is the actual content of the standard, albeit that traces in literature were scarce, and mainly high level. The decomposition of the content is captured in table 3.

In contrast with the previous decomposition, traces to development and management aspects of standards are easily found in the three studies, but also broader in many other literature. Many studies on standardization are focused on the development of standards (Folmer et al., 2009), so this is not really surprising. Table 4 contains the decomposition for development and maintenance.

Nr.	Item	Definition	Literature	Remarks
B.A.	**Meta Solutions**	**Approaches selected as fundament for the design of the standard**	**All**	**Fairly limited present with exception of architecture.**
7	Paradigm (approach)	A high level paradigm as fundament for the design approach.	1	
8	Methods/Languages	Selection of methods and languages to be used in designing the solution	1	
9.	Architecture	Architectural design choices of the standard, including functional and technical architecture and relationships with other standards.	1,2,3	Broad container, for instance relationship with other standards, or selecting new innovative techniques is part of architecture.
B.B.	**Conceptual Solutions**	**The design of the solution in concepts like descriptions and models.**	**1,2,3**	**Very limited references, while it was expected to be the core of the semantic IS standard.**
10.	Domain model (requirements)	A description of the domain environment of the standard.	1,2,3	
11.	Constraints	Constraints described as solution, expressed like business rules, related to the standard. These rules can express data dependencies based on the process status.		
12.	Process	The design of the flow of activities encapsulated within the standard. This might include process diagrams, actors involved, timing, error handling, cancellation process, etc.	1,3	
13.	Data / Information	The design of static information solution encapsulated within the standard. This might include messages/documents, ontologies, code lists, taxonomies, data dictionary, sharable data components, etc.	1,3	
B.C.	**Technical Solutions**	**The design of the solution in technical artifacts.**	**1,2,3**	
14.	Format	The format of the technical solutions in which the conceptual solutions are represented. (also syntax)	1,2,3	
15.	Medium (Transport)	Solutions related to technical communication aspects.	2	

Table 3 – Detailed elements of the concepts.

Nr.	Item	Definition	Literature	Remarks
C.D.	**Development & Management Process**	**The line of activities related to the development & management of the solutions the standard offers.**	**1,2,3**	**Includes Maintenance Requests**
16.	Initiation	The initiation process of exploring new maintenance requests or requirements related to the standard.	1,2	
17.	Design	The design process of creating solutions for requirements and maintenance request.	1,2,3	
18.	Formalize	The transformation of the design of the solution in the requested formats, both conceptual and technical.	1,2	
19.	Review & Testing	The review of the formalized solution by the stakeholders. Eventually it can also be tested in practice.	1,2	
C.C.	**Organisation**	**Activities related to the organization of the development and management of the standard.**	**1,2,3**	
20.	Quality Management	Activities related to quality Assurance and benchmarking the standard.		
21.	Rights policy	A description of the chosen rights policy for the standard.	1,2,3	
22.	Governance	The description of the governance model for the organisation of the standard. Including decision making, release policy and complaints handling.	1,2,3	Includes workgroup structures and decision making processes (consensus).
23.	Finance model	The financial model chosen for financing the costs of the development and management processes.	1,3	Not elaborated. Membership fee is mentioned.
24.	Vision / Strategy	The long-term vision for the standard, and its strategy for fulfilling the vision.	1,2,3	Includes openness strategy.
C.B.	**Marketing**	**Activities related to setting the standard in its market.**	**1,2,3**	
25.	Promotion / Adoption strategy	The strategy and its activities related to the promotion of the standard for achieving the desired adoption rate, including addressing the status of the standard by both the own organization and external organizations.	1,2,3	
26.	Compliancy strategy	The strategy to test and assure compliancy of implementations to the standard, by for instance having a certification program.	1,2	
27.	Communication strategy	The overall strategy about communication with different stakeholders using different communication channels. Also includes the strategy related to the publications of the documents in which the standard is expressed.	1,2	
C.A.	**Compo-**	**The development of artifacts useful for**	**1,2**	

	nent Deve-lopment	**implementers of the standard.**		
28.	Compon-ents & Tools	The availability of components that can be used for implementations of the standard, just as support tools helpful during implementation. A validation service is a common example.	1,2	

Table 4 – Detailed elements of the development & management.

Finally, the appliance of the standard is part of the domain of the standard since its use, but also available implementation support, are attributes of a semantic IS standard and do influence potential adoption, etc. This decomposition is described in the following table:

Nr.	Item	Definition	Literature	Remarks
D.A.	**Knowledge transfer**	**Activities related to the dissemination of knowledge about the standard.**	**1,2**	
29.	Helpdesk	The availability of a helpdesk to answer (implementation) questions about the standard.	1	
30.	Training	The availability of a training program to share knowledge about the standard.	2	
31.	Consultants	The availability of consultants/implementers for the standard.	1	
32.	Pilots (support)	Documentations about pilot implementations and the availability of support for pilots.	1	
D.B.	**Implemen-tation**	**Support activities regarding implementations of the standard.**	**1,2,3**	
33.	Reference Implemen-tation	Documentation about reference (good example) implementation of the standard.	1,2,3	Includes also the often mentioned implemen-tation guide.
34.	(certificated) Implemen-tations	Information about implementations of the standard, including involved stakeholders and if certified.	1,2	

Table 5 – Detailed elements of the appliance.

This model of semantic IS standards is graphically depicted in appendix 1.

6 Explorative case: SETU

The SETU was chosen as first explorative case, because it qualifies as successful semantic IS standard and the first author of this paper is also one of the developers of the SETU standard, even though this implies limitations to the general applicability of the case study results. SETU is a standard for the Dutch Temporary Staffing industry, and standardizes timecards and invoices amongst others. Our approach was to describe all 34 aspects from the model for SETU, and make it a normal textual description. After that, we showed this textual description of what SETU constitutes to four other SETU experts.

During the creation of the textual description of the SETU standard the model performed like an easy to use guideline, by which the description of SETU was quickly written. The result however looks broad and complete (see appendix 2 for the full description). By giving more

detail on every attribute the description could have become even more comprehensive. Other SETU experts did confirm that the description fits the actual situation of SETU.

7 Multiple case study: XCRI

Following the SETU case study, a second more extensive case study was planned. A class of students (master Business IT at the University of Twente) was involved in an experiment to measure the quality of a semantic IS standard. The standard XCRI (for exchanging course-related information) was chosen, because the education domain is recognizable for students and the XCRI is relatively simply, compared with standards like RosettaNet, and a quite complete overview is presented on the Internet (www.xcri.org).

The model of a semantic IS standard was used by half of the groups during class. The other groups had to find out how to perform a quality assessment. As a preparation, the students received. a week in advance, two articles about semantic IS standards (Nelson et al., 2005; Zhao et al., 2005). They however had no a priori knowledge of neither the XCRI standard, neither the model of semantic IS standards. The assignment was to describe the XCRI standard. Their time was limited to approximately 20 minutes. Two simulated experts were present and responded to questions asked by the students by e-mail. They answered the questions based on a Q&A with one of the actual XCRI developers. The students were divided in six groups of two or three students each. Three groups used the model, three did not. The two experts ranked the descriptions of both groups.

The results of the groups without model were generally narrow, technical, and seemingly random descriptions of XCRI. One group did actually use the framework of Nelson et al. (2005) to describe some aspects of XCRI. They mainly used the easy accessible information on the web page of XCRI.

The model user groups succeeded all in delivering a more comprehensive and broad description of XCRI. Yet, because they were focused on using the model, they had to rush to finish in time. In contrast to the other groups, they were looking for specific information about the XCRI standard. The results of these groups also included information about the development & management organization and information about implementations of the XCRI standard. Both were missing in the descriptions of the other groups.

During evaluation, the groups responded that they welcomed the model as a guideline. The groups without the model requested a guideline. However, according to the model user groups the descriptions of the model need clarification. Even guidelines on how to use the model were requested. Of course we have to keep in mind the limitations of this case study, including the fact that the users were students with no experience in this area, which is different compared to the intended user group that is involved in standardization. The intended users have more experience and knowledge in general but also regarding standardization than the students, which might explain the fact that the students were requesting for guidelines, and had some problems in understanding the descriptions.

8 Discussion

The presented model of semantic IS standards shows the broad context of this kind of standard. A semantic IS standard is much more than only a specification. It seems that the experts have come up with a recognizable model, because with only using three literature references we were able to find traces of all aspects in the model within the three literature reference. That might even suggest that a more elaborated model is achievable, although we are not sure if this adds much value. Although the case studies are methodological not optimal proof for validating the model, it still shows that there is much potential in using this model for describing semantic IS standards. Ofcourse the aggregation within the model is arguable, just as the categories in which all elements are categorized. However there is no need for the best model of a semantic IS standard. To our knowledge this is currently the first model of a semantic IS standards, and other models would be welcomed.

9 Conclusions & Further Research

Our main research question was: What constitutes a semantic IS standard? Our model contains four main areas:

a. Context

b. Content

c. Development & Maintenance process

d. Appliance

These are decomposed in 34 concepts. Most of these concepts are found in existing literature. The SETU description showed model's usability for describing one semantic IS standard. The XCRI case confirmed potential added value, and also delivered some valuable feedback for improvements.

Next to better understanding semantic IS standards, this model can be used as fundament for more elaborate research on specific concerns of semantic IS standards, like quality or development process or adoption or openness. Finally, this model can be used to describe and compare different semantic IS standards, for instance for selection purposes when competing standards are present.

This model is a first step in gathering more understanding of semantic IS standard. It can be enriched and validated, which is recommended as further research. Enrichment needs to be done by identifying more literature for the grounding of the model, and validation by performing more case studies. Since most literature is about development and adoption of standards, it is not surprising that these aspects are most mentioned in literature. Context and content characteristics receive little attention. Further research about the context and particular the content of the semantic IS standard is needed to fill this gap.

The identified attributes are in a sense steering factors. Combining other research, for instance on the adoption, quality, or openness of standards with our model, may lead to practical highly relevant outcome of which attributes need to be tuned for improved openness, quality, adoption, etc., of semantic IS standards.

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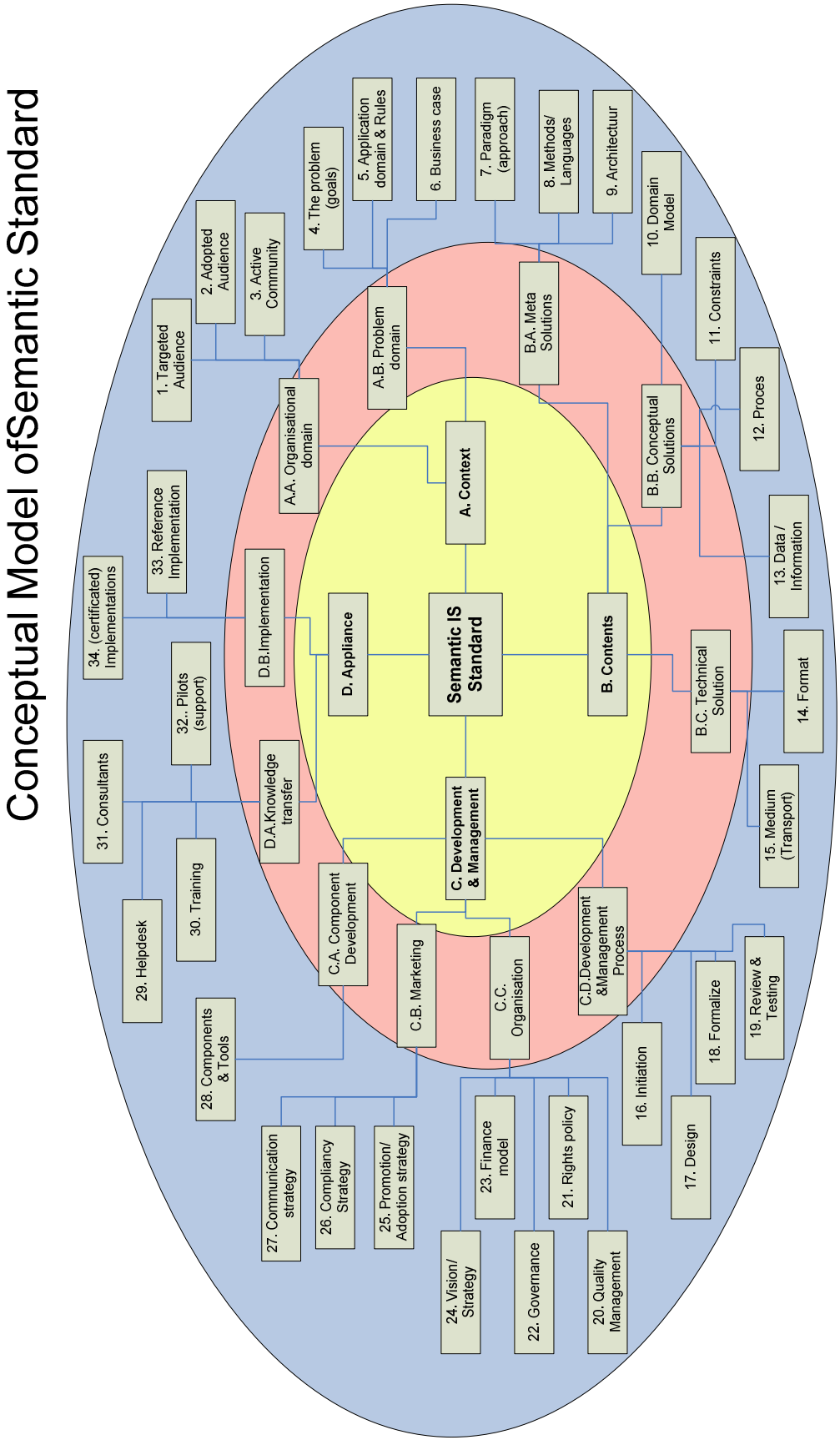
Appendix 1 – Conceptual Model of a Semantic IS Standard



Appendix 2 – SETU case result

This section will describe the SETU standard by using the model of semantic IS standard starting from A till D.

The SETU standard is characterized by an active community of representatives of the largest temporary staffers (Randstad, USG, Adecco, Manpower amongst others) together with the standardization experts of TNO and support of the sector organization ABU. The adopted audience includes the same temporary staffers but with also several middle-size temporary staffers, a list of staffing customers and software vendors offering solutions mainly for temporary staffing companies. The targeted audience is broader, since it includes every staffing companies and customers, and does also include software vendors from the procurement domain (e.g. SAP) which are currently not part of the active community or adopted audience.

SETU standards are a solution for effective and efficient inter-organizational communication about temporary workers. The application domain is within the Human Resources domain, including temporary staffers, staffing customers and service providers. Privacy laws are applicable, just as standard laws for e-invoicing. The domain is characterized by a handful of large dominant staffing companies, and thousands of niche suppliers regarding their ICT often dependent on software suppliers. The scope is limited to the primary process of selecting & ordering, the assignments, time card reporting and invoicing.

The SETU business case is quite obvious, although difficult to estimate. The main savings are present in the time card process and invoicing. Tools are available to calculate potential savings, but since everybody understands that for each stakeholder the business case is positive there is not much need for further research on the business case.

SETU has chosen for a model based approach, which is documented as development method for SETU standards. The paradigm can be called “message based”, in contrary to “service based”. As much as possible SETU makes use of existing methods and languages, like UML, SBVR, Schematron, XML & XML Schema. Architecture is very important to SETU on different levels. First the relation between the different SETU standards is important and documented. Second the relation with the mother standard hr-XML is described and continuously monitored. SETU representatives are active in hr-XML workgroups.

The core of the SETU standards is its models. Starting with the domain model to sketch the problem situation. Although SETU does not standardize the processes, they are captured in process models as reference examples and include options for corrections as well. SETU standardizes the data in messages (for instance the timecard message), and includes a data dictionary and code lists (for instance expense types). The SETU technical format is XML and XML Schema. To support the SETU adopters SETU does also include a “transport” guidelines on which protocols to use for exchanging messages.

The SETU uses a development process, initiated by the demands of the stakeholders (and approved by the SETU board), within workgroups the topic is explored and solutions are

designed and formalized. Finally a review process is started before the workgroup hands over its work to the board for the release decision. The maintenance process is based on the filed maintenance requests, which after a threshold has passed and after approval of the board, will be picked up by the workgroup in the same development process.

The SETU standards are developed and maintained by the SETU organization; a not-for-profit organization. Its member contains temporary staffers and service providers. Part of the quality management is a document way how the standard is developed, reviewed and released. SETU standards are open, meaning that they are free to download and do not contain IPR. The board consisting of members and the ABU decides and assigns the workgroup with a specific task. Complaints will be handled by the board as well.

The financial model consists of a membership fee, in combination with funding of the sector organization (ABU). SETU does not have explicit long-term visions. It plans its activity on year-basis. Still it wants to deliver effective solutions for temporary staffing at minimal costs. Recently SETU has set up a promotion strategy to fasten the adoption process of the standard. This strategy contains the planning of events and publications. Part of this strategy was also the effort that was put on getting SETU standard on the comply or explain list of the Dutch Government, giving status to the SETU standards. SETU has a publication strategy which releases documents on four levels: To the public, to SETU participants, to SETU workgroup members, or to SETU Board members. The distinction between SETU participants and the public is made to give participants advantage in relation to the membership fee they pay. A Mailing list is used for communication purposes.

The compliancy strategy is that SETU on purpose avoids this area, which means there is also no certification program. However SETU supports validation. With exception of the validation service SETU does not have components or tools available for implementation. In the past SETU supported the development of an open source component for time card communication based on the SETU standard. SETU has a highly knowledgeable helpdesk. Irregular, there is a SETU course available. Although SETU does not have preferred consultants, does not support pilots, or have reference implementations available, SETU does support incidental potential problematic implementation with high impact.