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Quality Measurement of Semantic Standards

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Abstract. Quality of semantic standards is unadressed in current research while there is an explicit need from standard developers. The business importance is evident since quality of standards will have impact on its diffusion and achieved interoperability in practice. An instrument to measure the quality of semantic standards is designed to contribute to the knowledge domain, standards developers and might ultimo lead to improved interoperability. This instrument is iteratively designed with multiple case studies. This paper describes the rationale and research design, just as current status and future plans.

Keywords: quality, semantic, standards, interoperability

1.1 Problem Description

Little scientific literature addresses the issue of quality of semantic standards (Folmer, Berends, Oude Luttighuis, & Van Hillegersberg, 2009). Sherif and Egyedi state that their paper (Sherif, Egyedi, & Jakobs, 2005) is the first to address standards' quality, albeit for technical standards. Regarding semantic standards, Markus asserts that the quality of a standard correlates with the adoption of that standard: "The success of Vertical Information Systems standards diffusion is affected by the technical content of the developed standard, …" (Markus, Steinfield, Wigand, & Minton, 2006). To our knowledge, in public policy circles, the quality of standards is mentioned for the first time in a whitepaper of the European Commission in 2009, where it is stated as a policy goal to "increase the quality, coherence and consistency of ICT standards" (Modernising ICT Standardisation in the EU - The Way Forward, 2009). In the meantime within the EU standardisation has become top priority in order to support the stabilisation of a common market and the unification of Europe (Hommels, Schueler, & Fickers, 2008). Standards are often seen as mean to achieve interoperability needed for social and economic goals, for example by the Dutch government (The Netherlands Open in Connection - An action plan for the use of Open Standards and Open Source Software in the public and semi-public sector, 2007). An example of economic relevance is the well documented study of the costs of imperfect interoperability estimated at $1 billion in the US automobile sector (Brunnermeier & Martin, 2002).

1.2 Goal & Research questions

The main goal of this study is to **build** an **instrument** to measure quality of semantic standards in order to **make quality of standards transparent.** To be able to fulfil this goal, research questions will be answered, amongst others:

- What is the state-of-the-art on quality measurement of semantic standards?
- What are the requirements for the instrument?
- What constitutes a semantic standard?
- What characteristics determine the quality of the standard?
- How can the quality characteristics be instrumentalized?

1.3 Research method

To be able to answer the research questions we categorized our research in order to be able to design our research. The summary of the characteristics is as follows:

- Research type: Design science in IS research
- Research epistemology: Interpretive
- Research design: Mixed methods
- Research methods/approaches: Several, including focus groups, work-shops, surveys and case studies.

The new and innovative design of an artefact which solves a wicked problem is typically design science research (Hevner, March, Park, & Ram, 2004). Structured literature review has been used to prove the innovative character, while a survey was used for identification of the wicked problem. This is the first phase of the study which shows the applicability of design science research.

The second phase is the actual design and evaluation according in line with design science, and is graphically depicted in the figure 1.1. A state-of-the-art analysis was performed on the current status of the knowledge base to identify constructs to build on. Workshops and expert sessions were used for gathering requirements for the desired solution. The iterative design will consist of minimal two design cycles, consisting of one case study for evaluation purposes within each design cycle.

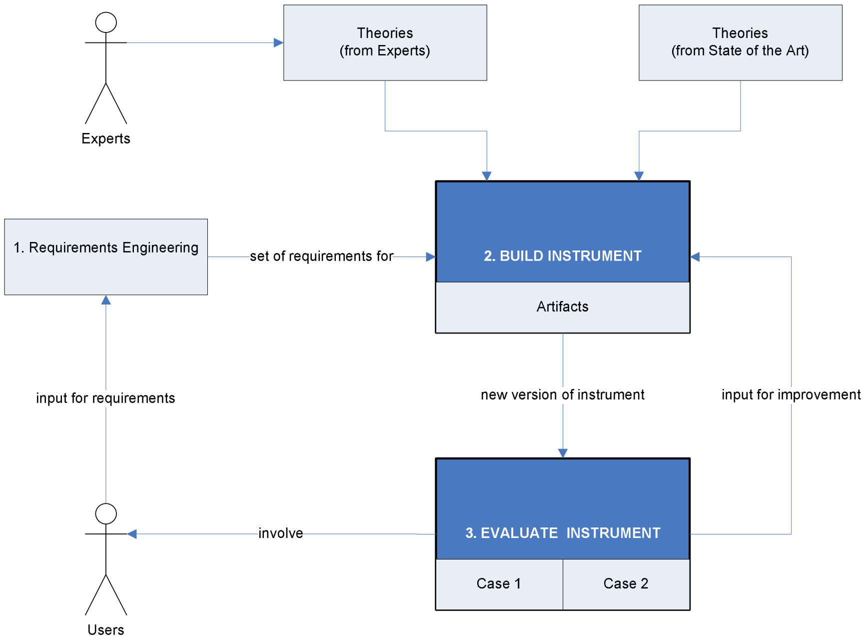

Fig.1.1. Overall research design

1.4 Problem validation

The results of the structured literature review show that semantic standards are poorly addressed in top 25 information system and management journals (Folmer et al., 2009). The research labels the quality of semantic standards topic as research gap in current knowledge base.

Representatives from semantic Standard Development Organisations (SDOs) largely support the hypothesis that the quality of their standards can be improved, just as they support the hypothesis that quality improvement of their standard might lead to improved interoperability in practice. These hypotheses were tested in a survey among 34 international semantic SDOs, including GS1, HL7, hr-XML, Papinet, amongst others (Folmer, Oude Luttighuis, & Van Hillegersberg, 2010).

In order to improve the quality of their standards, semantic SDOs might use an instrument to measure the quality and create transparency about the quality. If being developed 81% of the respondents is interested in using the instrument (Folmer, Oude Luttighuis et al., 2010).

By performing this structured literature review and survey, we proved our research to address both a research and a business gap.

1.5 State of the Art

Although quality of semantic standards defines a research gap, both standardization and quality are two well developed knowledge areas. The state-of the art analysis helps us to define our concepts, first of all the notion of semantic standards, which includes business transaction standards, ontologies, vocabularies, messaging standards, vertical industry standards, and many more terms. Often, semantic standards include XML-based syntax, but the value of the standard is its description of the meaning of data and process information to achieve semantic interoperability. Semantic standards can focus on a single industry sector or purport to be applicable across sectors (Steinfield, Wigand, Markus, & Minton, 2007).

Quality is defined as fitness for use (Juran & Gryna, 1988), which in our context defines quality of the standard as its ability to achieve the intended purpose of the standard. For semantic standards this means the quality is the fitness for achieving semantic interoperability. This implies that quality deals with both intrinsic aspects (the specification) and situational aspects (external environment) of the standard.

Measurement is defined by ISO (ISO/IEC, 1984) as a set of operations with the object of determining a value of a quantity. Our measurement instrument is a tool that supports the determination of values of quality aspects of the semantic standard at hand.

In the design phase, the state of the art analysis is used for identification of quality aspects, which were found, but only in a scattered and probably partial sense, and focussing on particular popular subtopics in literature, like the standardization process. Interesting is the literature about quality from the software engineering domain. We also found a meta language for quality of software (Garcia et al., 2009) to be useful in the semantic standards domain as well.

1.6 The design process

Our design starting point has been a requirements engineering study among potential users, performed in two workshops. The intended user is described as the expert from an SDO who wants to improve the standard. The identified requirements are leading in the design process. The top goal “To support semantic SDO’s in developing high quality standards” has been decomposed into three level-two goals, which have been further decomposed:

- Useful for different SDO’s: the instrument should be sufficiently generic to be used by many semantic SDO’s.
- Able to efficiently determine the quality and give improvement suggestions: it should be efficient to use, but also give improvement suggestions to the user.

- Have useable results for SDO's: the outcome should be useful and valuable for SDO's.

Based on the full set of requirements, structured in a goal-tree, our design started by identifying the main construction of the instrument. This has led to the following structure and representation of the instrument Quality Measurement of Semantic Standard (iQMSS):

Table 1.1. Constructs of instrument

instrument Quality Measurement of Semantic Standards (iQMSS)

	Specification Quality Model Semantic Standard (QM SS)	Specification Semantic Standard Model (SSM)	Implementation
M2	1. Quality Language (QL)	I. SS Language (SSL)	A. Development Environment
M1	**2. Generic QMSS**	**II. Generic SSM**	**B. GMI Generic Model Implementation**
M1	3. Customized QMSS	III. Customized SSM	C. SMI Customized Model Implementation
M0	4. Measurement Result	IV. Semantic Standard	D. Measurement Result Report

Model of (M2 → M1); Customization of (M1 → M1); Model of (M1 → M0)

We distinguished three different subdomains in the design of iQMSS: the quality model, the semantic standard model, which both need implementation to be instrumentalized. Each of these span different levels, based on "model of" relation or generalization specilization relation. The type of relation and M-levels according to the Model Driven Architecture (Kleppe, Warmer, & Bast, 2003) are presented in the table.

Based on the requirements it was determined that there is a need for a general version of the instrument, but to be valuable it needs to be specialized for each standard as subject for the measurement.

Based on the state of the art analysis, it was decided to use the work of SMM (Software Measurement Metamodel) and SMML (Software Measurement Modelling Language) (García et al., 2006; Garcia et al., 2009) as Quality Language (QL) and Semantic Standard Language (SSL) on the M2 level. The SMM language is based on a set of existing ISO definitions for many concepts relevant in a quality model, and although designed for software it fits the domain of semantic standards as well.

First, the Semantic Standard Model (SSM) is addressed before the actual quality model (QMSS) is developed. The SSM should indicate what the domain of the standard is, it identifies the attributes of the standard that form the point of action for the quality instrument. Every measurable quality aspect of the standard should be targeted at some attribute in SSM. In fact, the SSM defines a semantic standard in detailed.

1.7 Iterative design cycles

The iterative nature of our design resulted in an early first version of the the Quality Model for Semantic Standard (QMSS), and a first explorative case study (Folmer, Van Bekkum, Oude Luttighuis, & Van Hillegersberg, 2010).

The first design uses several sources, particularly from ISO 9126 (ISO/IEC, 2001), which proved to be a valuable fundament for QMSS. At the highest level, the QMSS structures the quality aspects in the categories: Functionality, Reliability, Usability, Portability, Maintainability, Adoptability and Openness. A first explorative case study was performed for the SETU standard, a semantic standard for the temporary staffing industry, and has led to an extensive list of improvement suggestions for the next design cycle of the instrument. In the next design cycles, the QMSS will be improved and evaluated, but also the emphasis will shift to building and evaluating the implementation of the models (iQMSS).

1.8 Conclusion & Further research

Currently, the first design cycle has been completed, but several more are needed. Further work needs to be done on the state-of-the-art analysis, including reflection on the original problem statement and project plan for possible alterations based on the new knowledge. The current version of the SSM requires validation, which will be done using the literature found in the state-of-the-art analysis. In the next design cycles, experts will be consulted for identifying more quality aspects and determining how to measure them. The implementation of the models in tooling is also a next step. The evaluation of the final design cycle, as part of this study, will include a survey among the same participants from the problem statement survey. Thus, we return to our original proposition and fundament of design science research: solving real-life problems.

The main research contribution of this study will be:

- the validated quality model for semantic standards,
- an operationalization of this model into measures, performed on the attributes of a semantic standard.

Insight in their quality may help improve semantic standards. Ultimo, this may lead to improved interoperability and, from that, the achievement of economic and societal goals.

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