The Measurement of Quality of Semantic Standards: The Application of a Quality Model on the SETU standard for eGovernment[1]

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Abstract

eGovernment interoperability should be dealt with using high-quality standards. A quality model for standards is presented based on knowledge from the software engineering domain. In the tradition of action research the model is used on the SETU standard, a standard that is mandatory in the public sector of the Netherlands in order to achieve eGovernment interoperability. This results in improvement suggestions for the SETU standards, just as improvement suggestions for the quality model have been identified. Most importantly it shows that a quality model can be used for several purposes, including selecting standards for eGovernment interoperability.

Keywords: Semantic Standards, Interoperability, Quality, eGovernment

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1   Introduction

Interoperability is regarded as an important aspect of improving services of eGovernment (*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). Many European governments are developing interoperability frameworks, that promote standards as a crucial means for achieving interoperability (European Commission, 2004). Governments are releasing policies to promote the use of open standards to achieve interoperability, often focussing on semantic interoperability. Open standards are expected to be of high quality, a feature considered to be essential for achieving interoperability (Folmer, Oude Luttighuis, & Van Hillegersberg, 2010). Unfortunately, there is hardly any scientific research on semantic standards and interoperability in general, let alone on the specific topic of quality of semantic standards (Folmer, Berends, Oude Luttighuis, & Van Hillegersberg, 2009). Meanwhile, the importance of eGovernment interoperability is increasing (European Commission, 2009, 2010a; Kroes, 2010).

In this study we address this gap by applying a quality model constructed mainly from the field of software engineering to examine the quality of a specific standard (SETU). Because of the explorative nature and the integration of theory and practice, a participatory action research approach is appropriate (Lau, 1999). This is implemented by having the same authors that have participated in the development of the quality model and that have participated in the development of the SETU standard, perform the quality evaluation.

By performing this research we gather knowledge about:

1. The quality model: Is the model adequate?
2. The quality assessment results: How useful are the results in practice?
3. The application of the quality model: What new opportunities arise?

We start in the next section by setting the scene, including the Dutch government policy on interoperability and standardisation. The following sections will introduce the quality model and the application on the SETU standard. We report our findings and conclusions in the final section that will answer the questions above, and discuss further research directions.

2   Dutch Government Policy

Dutch government published the ambitious action plan "Netherlands Open in Connection" in 2007 (*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), by which it tries to achieve the following goals:
- Increase interoperability of information systems in the Dutch public sector by accelerating the use of open standards.
- Reduce dependence on suppliers of ICT by means of faster introduction of open standards.
- Promote a level playing field in the software market by using open standards

This plan includes both interoperability between Governments and interoperability between Governments and business in order to tackle all kinds of social and economic challenges. It promotes the use of open standards, by introducing a compliance regime and lists of standards. Two types of lists are introduced:

1. A list of "comply or explain" standards. These standards are often sparsely used within the Dutch public sector, but the list mandates use of these standards, in order to change that situation. The standards on this list are mainly focused on semantics, like SETU

(procurement) and StUF (administrative), but in practice several technical standards (like JPEG) have also entered the list.

2. A list of "frequently applied standards", standards that are widely used in the architectures of information systems. These 'defacto' standards are often technical, world-wide standards aimed at the lower layers in the OSI reference model, like the TCP/IP-protocol, SMTP et cetera. This list supports purchasers in the public sector among others in tendering procedures.

The "comply or explain" list is related to the new regime, making it mandatory to use these standards in public organizations: "Action line 2: Institutions in the public and semi-public sector will introduce the "comply or explain and commit" principle for ICT orders. Public sector bodies and institutions are themselves responsible for the application of "comply or explain, and commit", using self-policing measures." (*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). "Comply or explain, and commit" means:

- Comply: apply established open standards when putting out orders for new IT systems or rebuilds and IT contract extensions.
- Explain: exception criteria are: no open standard is available for the desired functionality; the open standard is not supported by multiple suppliers and on several platforms; conduct of business and/or service provision would be unacceptably jeopardized, for instance when dealing with matters of security or breaking international agreements.
- Commit: give preference to the application of open standards so that an exception criterion no longer applies.

Standards on the "comply or explain" list have undergone a thorough process, including an expert advice, public consultation, advise of Standardisation Forum, and finally the decision by the Standardisation Board. The Standardisation Board and Standardisation Forum were established by decree by the Minister of Economic Affairs on March 27th, 2006 (*Open Standards*, 2010). The Standardisation Forum consists of experts from both industry and government, while the Standardisation Board only consists of highly ranked civil servants from different ministries. Each standard included on the list has a well-defined "functional scope" and "organizational scope" for which the policy is in place. The functional scope determines the functional area of the standard, eg. "Procurement of temporary staffing". The organizational scope determines the public domain to which the standard applies. Examples include municipalities, hospitals, or all (semi) public institutions.

Openness is the most important selection criterion for a standard. The definition of open standards that is used by Dutch government complies with the definition that is used by the European Commission as set by the IDABC program (European Commission, 2004):

1. The standard is approved and will be maintained by a non-profit organization, and ongoing development will be on the basis of an open decision-making process that is accessible for all interested parties.

2. The standard is published and the specification document for the standard is freely available or can be obtained for a nominal contribution. It should be possible for anyone to copy it, make it available and use it, free or for a nominal price.

3. The intellectual property – regarding any patents that may be present – of the standard or parts thereof is irrevocably made available on a royalty-free basis;

4. There are no restrictions on reuse of the standard.

The more recent second version of European Interoperability Framework 2 (European Commission, 2010b), contains a different and less strict definition but is not adopted by the Dutch (and other) government(s), and is not expected to happen in the near future.

Other less strictly defined criteria include the contribution of the standard to achieve interoperability and the usability of the standard (e.g. maturity). The latter are less strictly defined since it is not widely known when standards will optimally result in interoperability. Although the standards currently on the list do fit certain criteria, the quality of the standards remains uncertain.

Other European countries are dealing with the same topic, and influence each other. Many countries have a national interoperability framework, including the UK, Germany, Estonia, etc. The Dutch policy is heavily influenced by the way the Danish government operates with regard to this subject. The use of lists of standards is also common in several countries, including Belgium and Denmark. However, the implications of the policies differ in each country and currently attempts are made to align the policies. The debate on the controversial draft version of the European Interoperability Framework 2.0 shows there is a long way to go ("European Interoperability Framework 2.0 (leaked draft)," 2010). An essential part within the national interoperability frameworks is the role of standards. Many focus is currently on selecting open standards within these frameworks but since openness is only one quality aspect it is foreseen that this will be broadened to achieving and selecting high quality standards in general.

3 The Quality Measurement Instrument

This research is about semantic standards, that is, standards at the presentation and application layer of the OSI model (Steinfield, Wigand, Markus, & Minton, 2007). We define the quality of a semantic standard by its ability to achieve its intended purpose — semantic interoperability — effectively and efficiently. Such quality deals with both intrinsic aspects (the specification) and situational aspects (external environment) of the standard. This definition applies Juran's definition of quality — fitness for use (Juran & Gryna, 1988) — to the semantic standards domain and is in line with the ISO 9126 definition: the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs (ISO/IEC, 2001).

Little research has been performed on semantic standards (Folmer et al., 2009), which makes it no surprise there was no instrument available to measure the quality of semantic standards. Software Engineering on the other hand, is a discipline with a rich history of research on quality, resulting in standards dealing with quality of software engineering. Using the Software Measurement Metamodel (SMM) and Language (SMML) (García et al., 2006; Garcia et al., 2009; Mora, García, Ruiz, & Piattini, 2008)it is possible to use a consistent approach towards quality terminology. Based on ISO and several other definitions Garcia defines an ontology (Garcia et al., 2009), of which we use:

- Quality model: The set of measurable concepts and the relationships between them, which provide the basis for specifying quality requirements and evaluating the quality of the entities of a given entity class.
- Information need: Insight necessary to manage objectives, goals, risks, and problems.
- Measurable concept: Abstract relationship between attributes of entities and information needs.
- Attribute: A measurable physical or abstract property of an entity that is shared by all the entities of an entity class.
- Measure: The measurement approach defined and the measurement scale (a measurement approach is either a measurement method, a measurement function or an analysis model)

In our case the entity class will be semantic standards, while the entity is the standard under investigation. The quality model of a semantic standard evaluates the measurable concepts that are associated with the information needs. The measurable concepts relate to the attributes of a semantic standard for which measures are defined.

Starting point for the development of this quality model is the identification of measurable concepts. We have used multiple approaches to gather a list of measurable concepts. The foundation was laid out by the ISO 9126 standard (ISO/IEC, 2001). As it targets the evaluation of software quality, we had to eliminate the aspects that are irrelevant to standards. Secondly, we used a focus group for validation of the concepts identified and identification of other measurable concepts. With the same purpose, several other reports were used as well, and finally the result was tested in a case study within the education domain. A full description of the process and its outcome is given in (Krukkert & Punter, 2008). In summary, the measurable concepts that have been identified, are visualised in figure 1.
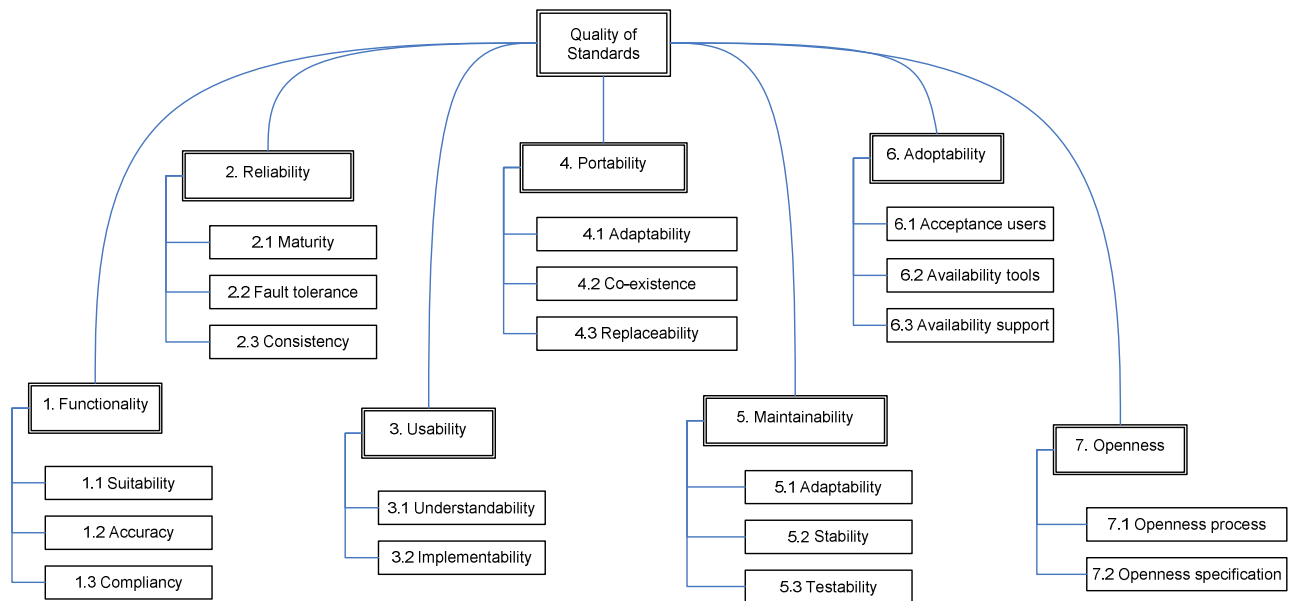
Figure 1.   Quality model for semantic standards.

	Measureable concept	Definition	Adapted from
1.	Functionality	The capability of the standard to provide functions which meet stated and implied needs when the standard is used under specified conditions.	ISO
1.1	Suitability	The capability to provide an appropriate set of functions for specified tasks.	ISO
1.2	Accuracy	The capability of the standard to provide interoperability, with the needed degree of precision.	ISO
1.3	Compliancy	The capability of the standard to adhere to other standards, conventions, or regulations in laws and similar prescriptions.	ISO
2.	Reliability	The capability of the standard to maintain a specified level of performance when used under specified conditions.	ISO
2.1	Maturity	The capability of the standard to avoid failure as a result of faults in the standard.	ISO
2.2	Fault tolerance	The capability of the standard to maintain a specified level of performance when a fault occurs.	ISO
2.3	Consistency	The level of ambiguity within the standard.	
3.	Usability	The capability of the standard to be understood, learned, and used, when used under specified conditions.	ISO
3.1	Understandability	The capability of the standard to enable the user to understand whether the standard is suitable, and how it can be used for particular tasks and conditions of use.	ISO
3.2	Implementability	The effort needed to implement the standard.	
4.	Portability	The capability of the standard to be transferred from one environment to the other.	ISO
4.1	Adaptability	The capability of the standard to be adapted for different specified environments without applying actions or means other than those provided for this purpose for the standard considered.	ISO
4.2	Co-existence	The capability of the standard to co-exist with other independent standards in a common environment.	ISO
4.3	Replaceability	The capability of the standard to be used in place of another specified standard	ISO

		for the same purpose in the same environment.	
5.	Maintainability	The capability of the standard to be modified. Modifications may include corrections, improvements or adaptation to changes in environment, and in requirements and functional specifications.	ISO
5.1	Adaptability	The standards possibilities to adapt.	
5.2	Stability	The capability of the standard to avoid unexpected updates of the standard or unexpected changes in the environment.	ISO
5.3	Testability	The capability of the standard to be validated.	ISO
6.	Adoptability	The adoption of the standard within the domain.	
6.1	Acceptance of users	The level of adoption of the standard by the users.	
6.2	Availability tools	The availability of tools that support the implementation of the standard.	
6.3	Availability support	The availability of knowledge and implementation support about the standard in the market.	
7.	Openness	The openness of the standard based on openness criteria	
7.1	Openness Process	The level of openness of the development and decision-making processes.	
7.2	Openness Specification	The level of openness of the specification.	

Table 2.   Identified measurable concepts.

In next steps the attributes and the measures need to be defined, just as a scoring and weighting mechanism, because not every measure can be scored in the same way, and also the weights of a measure will differ based on the importance of the measure in relation to the quality.

The model is intended to be used as self-evaluation tool by standards developers. In general this user group aims to achieve the highest quality in standards they develop, but is often unaware of the quality and possible improvements to their standards (Folmer et al., 2010). When the model is completed, it is foreseen that the use process starts with a preparation phase during which the appropriate measures will be chosen, combined with the measurement approaches, the weights of the measures and measurable concepts in relation to the overall score. The execution phase consists of performing the measurement, setting up the report by analyzing the results and will end by evaluating the measurement process.
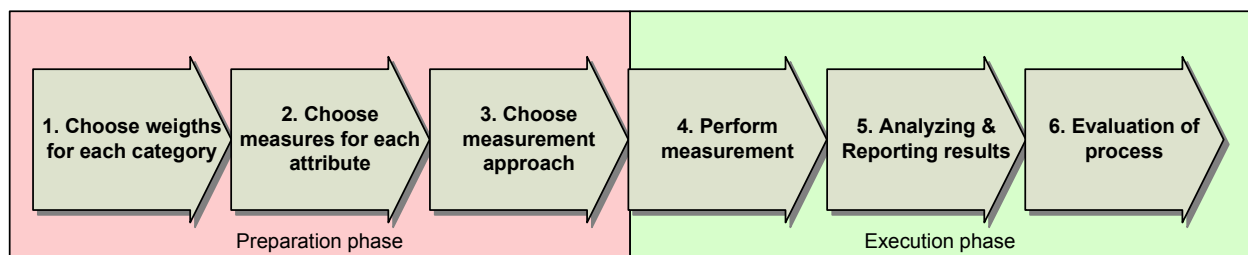

Figure 2.   How to use the quality model.

Realizing that the quality model can be enhanced and further decomposed, we decided for an iterative design to make sure the developments will contribute in practice. The current model is already perfectly suited to be tested in practice, although in the current development phase only step 4 and 5 from the execution phase can be tested. In tradition of action research, we applied the instrument to a co-developed standard in retrospect. Application was done by two co-developers by going through the list of quality aspects. The results were validated based on review of two different co-developers.

4 Application of the quality model to the standard for temporary staffing in the Netherlands

The instrument (quality model) is applied to the SETU standard, which has been acclaimed by the Dutch government for achieving interoperability within the process of hiring temporary staffers through temporary service agencies. SETU is a set of specifications, including XML Schemas, for amongst others assignments, timecards, and invoices related to temporary staffing.

4.1 The application context

The instrument is intended to be used with every semantic standard, independent of the Dutch "comply or explain" list. For this application, however, we decided to select a standard from the "comply or explain" list, which means that the standard should have positive impact on achieving interoperability, implying high quality. Since May 2009, SETU is listed on the "comply or explain" list, which means that every (semi) public organisation has to comply with using the SETU standard when ordering temporary staffing is executed electronically.

The SETU standard is a semantic standard supporting the processes of temporary staffing. It is a Dutch localization of the international HR-XML standard (Van Hillegersberg & Minnecre, 2009).

4.2 Application of the quality model

The self-assessment is based on three different sources (see appendix 1). The subject is the SETU standard, which comprises four sub standards:

- SETU standard for ordering and selection version 1.1
- SETU standard for assignment version 1.1.
- SETU standard for reporting time & expenses version 1.1
- SETU standard for invoicing version 1.1

Because of the extensive size, this paper does not include the complete scoring of attributes from the quality model, but a small set of one measurable concept (Usability) is included in appendix 2. Table 2 contains the overall score for each measurable concept from the quality model. Recommendations for improvement have been added, based on the findings.

	Measureable concept	Assessment	Recommendation
1.	Functionality	• The standard provides the functions that support the stated needs and is highly suited to a small focussed set of functions. • Scoping however is not consistent between different documents, which may easily lead to confusion about the scope: Does the scope of SETU involve all electronic transactions or limited to the primary process? And does it only focus on temporary staffing through staffing agencies, or are consultancy organisations also part of the scope? There is also need for a broadening of scope. • SETU standards contain options that have negative impact on interoperability. • Although SETU is compliant with laws and regulations, this fact may be stated more explicitly.	Adjusting (broadening) and aligning scope is required. More strictness (less options) will lead to improved interoperability Compliancy of SETU standards to laws and regulations can be more explicit.
2.	Reliability	• The SETU standards seem mature: a lot of information is available on the website. This however, includes outdated material.	Keep deprecated material separated from current

		Users will not understand that, and may easily select the wrong document. The SETU organisation has yet to prove its reliability in the future. The board could bring more balance to the representation of different types of stakeholders. • The standards contain possibilities for corrections, but with options. The correction process needs to be standardized as well. • The SETU data dictionary is an important addition to HR-XML, reducing ambiguity.	documentation. Update documents like the roadmap. Invite other types of organizations into the board of SETU. More attention on process standardization.
3.	Usability	• In general there are no major limitations to the usability of the SETU standard found in this study. The understandability of the highly structured specification documents seems straightforward. Especially the standard for reporting time & expenses however, may benefit from improved readability, since it has a remarkably low score on readability. To shorten the time required to learn the standard, it may be useful to develop and share learning material (or courses). Implementability for staffing customers is affected by the lack of SETU support of procurement vendors.	Have a closer look at the readability of the standard for reporting time & expenses. Availability of training material A better connection with the infrastructure of the systems of the hiring company is advisable.
4.	Portability	• The portability of the SETU standard seems in line with expectations: It is adaptable to suit specific customer demands and the co-existence with HR-XML is perfectly logical. In the future, the alignment with invoice standards requires attention.	Alignment with invoice standards requires improvement.
5.	Maintainability	• Most importantly, the SETU standard is maintained, stable and adapts to needs in practice. It has some flexibility to adapt to the different needs in projects. • Dependency on HR-XML is an issue, especially since HR-XML is changing its course lately. But also for instance the data definitions of HR-XML need improvement, just as version management. • Implementations of the standard can be tested by using the SETU validation service.	Improvement of HR-XML data dictionary in line with the SETU data dictionary. Keep up with HR-XML versions. Next step of validation should be certification.
6.	Adoptability	• The adoption of the standard varies. The level of adoption is high on the supply side, but low on the demand side (staffing customer). The latter may improve now that SETU is on the "comply or explain" list of the Dutch government, which is specifically targeted at the demand side. • In line with the above statement the adoption by the procurement software vendors needs improvement.	Promotion to staffing customers to enhance adoption. Promotion to software suppliers of staffing customers, especially the vendors of procurement software, like SAP and Oracle.
7.	Openness	• SETU is an open standard as confirmed by advice from an independent expert committee appointed by the Dutch government. Although SETU is not completely open on every detail, it apparently manages to deal with openness that befits the situation.	No recommendation.

Table 2.   SETU results.

5   Conclusions

In this section we look back at the three questions presented earlier and we will answer them subsequently:
• the quality model: Is the model adequate?
• the application results: How useful are the results in practice?
• the application of the quality model: What new opportunities arise?

5.1 The quality model: Is the model adequate?

It is expected, that only when the quality is known (visible), it is possible to improve the quality effectively. This thesis is supported by survey results amongst 35 semantic standard development organisations (Folmer et al., 2010). The respondents agreed that an instrument to measure the quality of the standards would be beneficial. This research demonstrates a first version of such an instrument by which quality of standards is assessable and becomes visible. The application of the instrument resulted in relevant improvement suggestions, even for a well acclaimed standard like the SETU standard. This leads us to answer this question positively, but there is much to improve. In general, since the applied instrument was not finished in every detail, the following holds and was already established prior to this application:

- Attributes, measures, and measurements approaches needs to be further defined;
- Just as scoring mechanisms and guidelines on how to perform the tests.

We can summarize these as more details and guidelines are needed for a strict repeatable measurement. More detailed and based on this study, we conclude:

- Future plans (like a roadmap) are not taken into account; the quality model is only looking at available results.
- The approach of modelling the processes and data is not part of the model.
- The content of a standard is captured in more items than just its specification. Especially for determining the quality, several other documents are important, apart from the specification.
- The openness of SETU is only marginally assessed by both the expert advice and this study. It would have been much more valuable to use the 10 requirements on openness (Krechmer, 2009). These 10 requirements are a broader and more balanced view on openness than a strict use of the definition of openness from the European Interoperability Framework.

A limitation of the approach is that the assessors are also co-developers of SETU. Would the instrument also be of use to "independent" quality auditors that are new to a standard? To perform such a quality assessment, deep inside knowledge is required; only using documentation will not have given the same result. This implies that only experts of the standard involved in the development process can use this quality model.

5.2 The quality assessment results: How useful are the results in practice?

To be able to answer this question, the assessment results were validated by two other co-developers of SETU, not involved in the application of the quality model.

Based on this study, it is impossible to state an explicit notion of semantic standard quality, like a certain number on a scale, or a value like perfect, sufficient, or not sufficient. Although the assessment gives the impression that there are no major flaws in the quality, supporting the thought that the quality is rather good, we can not prove this by means of this study. More importantly, it does show some possibilities for improvement, exactly what the instrument is aimed for. In no particular order, the most important suggestions for improvement are:

1. Adjustment (broadening) and alignment of scope is required

2. More strictness (fewer options) will lead to improved interoperability

3. Keep deprecated material separate from current documentation.

Worth noticing is that the SETU operating procedure is an important document for the quality assessment. This document can be further enhanced to be a "quality process" document. On the other hand, although the contrary was expected, the usability of the expert advice report was fairly limited in this assessment. It contains statements such as 'the usability is good', which may be sufficient for an assessment, but does not suffice as a fundament for starting quality improvements.

An unexpected eye-opener for SETU was the amount of outdated documentation on the website including deprecated versions of the standard. For the SETU organisation the outcome is valuable, and will be a starting point for a quality boost.

5.3 The application of the quality model: What new opportunities arise?

The introduction and use of the instrument may lead to improved quality of semantic standards. This will ultimately lead to improved interoperability and improved services to citizens and organisations by governments. The quality model can have additional applications, e.g.:

* For implementers of standards: to estimate the effort needed to implement the standard in the product/system based on the notion of the quality of the standard.
* Governments: before accepting a standard within an interoperability framework (or for the Dutch government the "comply or explain" list), it seems valid to have a proper notion of the quality of a standard that is broader than just the quality aspect of openness.
* For standard bodies: have a final check on quality based on the quality model, before a standard is released.
* In general: Benchmarking among standards.

Governments want to foster interoperability, not just any open standard. To select those open standards that have a positive impact on interoperability, the quality of the standard becomes relevant. This research sets the first step in linking standards and interoperability by introducing the quality model for standards.

6 Research considerations

There are several considerations to be taken into account, when assessing the research presented in this paper:

* Self evaluation: it is worth mentioning that this is a self-evaluation, meaning that the performer of the study measures his own work in the development of the standard. This is in line with the intended use of the instrument as a tool to improve the standard. However it has consequences on the outcome. Comparisons of measurements of different standards for instance, can not be made easily. The results will also be biased because of the involvement of the evaluators in the development of the standard.
* One application case is not enough to generalize: more studies are required in order to generalize our results. The same study can however already be performed on standards within other domains as well.
* The quality model needs to be further extended. By using a metamodel (like SMM (Garcia et al., 2009) the instrument can be easily extended to include additional quality aspects and measurements. The results so far are an instigator for further development of the model.

In future research, our goal is to extend the instrument further and provide enough detail to make the approach less dependent on the expert user. An improved version of the operationalized instrument, including manuals and support tools, will not only lead to richer results, but will open the way for benchmarking between standards.

Acknowledgement

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Appendix 1: The SETU sources

The self-assessment is based on three different sources:

1. Report of expert session of Dutch government (Van Hillegersberg & Minnecre, 2009).

2. All information available on www.setu.nl, this includes
- The specifications
  o SETU standard for ordering and selection 1.0
  o SETU standard for assignment 1.0
  o SETU standard for reporting time & expenses 1.0
  o SETU standard for invoicing 1.0
  o SETU standard for ordering and selection 1.1
  o SETU standard for assignment 1.1.
  o SETU standard for reporting time & expenses 1.1
  o SETU standard for invoicing 1.1
- General documents
  o Statutes of SETU organisation
  o By-laws of SETU organisation
  o SETU operating procedures
  o Covering note on SETU standards
  o Readability guide SETU standards
  o Roadmap SETU 2007/2008
  o Recommended practices for Transmission and Security 1.0
- Other documents on the website
  o The minutes of the workgroup meetings
  o Other

3. Information not available in documents, but available from SETU people.