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RESEARCH ABOUT BEFORE RESEARCH WITH STANDARDS

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Research about before Research with Standards

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1 Introduction

While designing or improving business processes, production routines or the digital exchange of data and documents, standards became essential components to build on. Often standardization is the only convenient approach to fulfill the economic and technical requirements with minimal administrative efforts and costs. Hence, the use and development of standards become increasingly important for an effective and efficient execution of business processes (de Vries 1999, p. 3f). Recent literature paid more and more attention to standards and standardization research. For example Jakobs (2003, p. 14) describes two emerging fields of research: research for standards and research about standards, whereby the former refers to the creation of standards during research and development processes and the latter focuses on the standardization processes from a scientific point of view (Jakobs 2003, p. 14). Additional to Jakobs a third research field can be identified in the recent literature: research with standards. Here the focus lies on using a standard (e.g. as fundament) to develop a new scientific artifact. The eXtensible Markup Language (XML), the Common Warehouse Model (CWM), or the Capability Maturity Model Integration (CMMI) are examples of important standards within the field of Information Systems (IS) research, as they are often used as methods, techniques or constructs within a design-oriented research process (see for example Declerck & Krieger 2006, Spies 2009, or Luftman & Kempaiah 2007). The available literature refers to many aspects of standards and standardization. Most of the research in this field deals with the development or the implementation of standards, the surrounding circumstances relating to technology, markets or users and the theoretical background why standardization succeeds or fails (see for example David & Greenstein 1990, Greenstein 1992, Weiss 1993, Rada 2000, or Markus, Steinfield & Wigand 2006). Unfortunately most of this research concentrates on one technology or very specific cases and there is hardly any general research about standards and standardization processes themselves (de Vries 1999, p. 6). We postulate that research about standards is essential before conducting research with standards. Due to epistemological reasons it is critical to use standards in a non reflective way while developing a new artifact. As the quality of the standard deployed may have a dominant influence on the artifact to be designed, its scientific grounding may as well influence the scientific grounding of the designed artifact. Referring to the available literature, a lot of papers deal with research about standards or with design-oriented research from an epistemological focus. However, the combination of both topics is missing.

We therefore suggest evaluating standards according to design science guidelines before using them in design-oriented research. We especially want to answer the following questions: Is it possible to assess a standard's scientific grounding by looking at its development process (Q1)? Are there classes or types of standards that are more likely to be positively assessed on the basis of their development processes (Q2)? In detail, which are the areas where standards are most likely to fail an assessment of their scientific grounding (Q3)?

The paper is based on a descriptive research design. At the same time our investigation provides conclusions concerning standards from an epistemological point of view. Rather than pursuing a detailed step by step approach, we intend to sharpen the awareness of researchers who design IS artifacts based on standards (research with standards) however well-known, accepted or wide-spread these standard may be.

The remainder of our paper is structured as follows. In the second section we discuss the terminology in the field of standards and look at terms such as “standard” and “standardization” as well as different standards development approaches we later on classify. The third section first gives an overview on the design science paradigm and evaluates an exemplary standard with respect to its scientific grounding. Subsequently the findings are generalized according to the previously introduced classification of standards development approaches. The results of the evaluation are discussed in section four. Finally the findings are summed up and a short outlook on future research opportunities is given in the conclusion.

2 Literature Review

2.1 Terminology

The terms “standard” and “standardization” are widely used in science and practice. Thus there exist a lot of definitions in the literature showing the missing consensus on the meaning of both terms (de Vries 1999, p. 137ff, Jakobs 2003, p. 4). However, the basis for a scientific discussion about standards is a clear understanding of the used terminology.

An overview of relevant definitions is given in de Vries (1999, p. 137ff). Unfortunately, none of the definitions available covers all existing standards. The definition of the International Organization for Standardization (ISO) for example is limited to standards as documents that were developed consensus-based (International Organization for Standardization [ISO] 2004a, p. 24). Others limit standards to technical specifications (European Parliament 1998, p. 3) or to specific problem domains (de Vries 1999, p. 155). Over all, most definitions focus only on consensus-based standards and are overlooking either the possibility of standards set by governmental institutions or those that emerged out of the market.

To assure that all kinds of IS standards can be considered in the following sections, we do not restrict an IS standard to a certain type of publication like documents, technical specifications, or others. Furthermore we assume, that IS standards are not limited to consensus-based development approaches (see section 2.2 for details). The only restriction we set is that the standard has to be related to the field of IS, but we do not specialize on particular technologies or sub domains within this field.

Even more diversity comes with the term standardization. As with the term standard there are many definitions available (de Vries 1999, p. 137ff, Jakobs 2003, p. 4). Although the ISO (2004a, p. 16) states that standardization “consists of the processes of formulating, issuing and implementing standards”, the usage of the term differs enormously within articles and books.

That means some authors cover the whole standardization process while others limit it to a single section of the process, for example the development or the implementation of standards. It is critical that these meanings can often only be understood through the context of the articles and a clear classification is missing. Table 1 shows some examples of the different use of terms related to standardization as well as their respective meaning in the given context, i.e. the whole standardization process, standards development or standards implementation.

Meaning	Term	Example sources
Whole standardization process	Standardization (process)	Belleflamme 2002, p. 153ff, ISO 2004a, p. 16
Standards development	Standards development	Nelson, Shaw & Qualls 2005, p. 378ff, Rada 2000, p. 19ff, Weiss 1993, p. 35ff, Zhao, Xia & Shaw 2005, p. 289ff
	Standard making	Zhao et al. 2005, p. 293
	Standardization (process)	Rada 2000, p. 20ff
	Creation of standards	Backhouse, Hsu & Silva 2006, p. 413ff
Standards implementation	Standards setting (process)	David & Greenstein 1990, p. 3ff, Jakobs 2002, p. 118ff
	Standardization (process)	David & Greenstein 1990, p. 5ff, Jakobs 2002, p. 118ff

Table 1: Examples of terminology used for the standardization process.

As table 1 reveals, there exists no consensus in this field. Rada (2000) for example, uses the term standardization in context to the development of standards (p. 20ff), whereby David and Greenstein (1990) talk about "standardization processes" associated with standards setting (p. 5ff). Others, like Belleflamme (2002), use the term standardization in a more generic way without referring to a specific part of the process (p. 153ff). It becomes clear that standardization is a comprehensive concept which is often used indiscriminately, even if only a specific section of the process is meant. Therefore it is recommended to specify the addressed process parts when dealing with standardization.

2.2 Standards development approaches

The main focus of this research is the standards development process. Hence, an examination of the prevalent approaches is necessary, but a review of the literature and existing approaches showed that there are no clearly dominating approaches. Nearly every organization or institution follows its own method or approach for developing standards. Nevertheless it is possible to identify similar approaches and aggregate them at a generalized level. For this end the distinction between de facto, consensus-based and de jure standards (see table 2) appears to be useful.

Type of standard	Description	Involved parties
De facto	Standards emerged out of the free interplay of market forces.	Single companies, social communities
Consensus-based	Standards developed by cooperation and consensus between several organizations.	Standards developing organizations, industry consortia
De jure	Standards established by governments or by law.	Governments, government-related institutions

Table 2: Systematization of standards development approaches (Weiss 1993, p. 36, Zhao et al. 2005, p. 293).

De facto standards are not explicitly developed – they emerge out of the market. This is for example the case, if a companies' product reaches a dominant market position only because of its features (Belleflamme 2002, p. 154, Hesser, Czaya & Riemer 2006, p. 120). As a consequence no generalized approach for de facto standards is visible.

The situation is different when analyzing consensus-based standards. Organizations like the Object Management Group (OMG) or the World Wide Web Consortium (W3C) normally utilize guidelines or regulations to develop standards. Unfortunately these guidelines are often very generic. Typical actions specified are a request for proposal or information on first drafts, some repeated evaluation, voting and modification stages and finally the release of the standards (Object Management Group [OMG] 2009, World Wide Web Consortium [W3C] 2009). Additionally, there are many ways to develop a standard. For example Rada (2000, p. 24ff) points out that a lot of organizations offer so called Fast Tracks to speed up the development time. Furthermore the voting rules for releasing or modifying the standard drafts are very different and often dependent on membership status (Zhao et al. 2005, p. 264). Likewise there are huge differences between the concepts for evaluation and validation of standards in respect of scope, complexity and transparency (Boh, Soh & Yeo 2007, p. 59).

The probably most rigorous approach is to be found with de jure standards. One example would be the Deutsches Institut für Normung e. V. (DIN). There exist regulations similar to consensus-based standards (Deutsches Institut für Normung e. V. [DIN] 2009). But furthermore government-related organizations releasing de jure standards mostly define additional requirements, for example details about the evaluation processes. Besides, the use or consideration of de jure standards may be mandatory (DIN 2009, Hesser et al. 2006, p. 109f).

However, the classification given in table 2 sometimes overlaps. The ISO for example is a standards developing organization that could be classified consensus-based as well as de jure. ISO develops standards in a consensus-based manner and simultaneously some of the developed standards reach a mandatory status, because of the large participation of governments or government-related institutions (ISO 2004b, p. 3ff).

It becomes obvious that no uniform approach for standards development exists. Every standards developing organization defines its own processes and more or less rigorous guidelines. Therefore it has to be examined to what extent standards satisfy scientific requirements when they are used within design-oriented research. The distinction between de facto, consensus-based and de jure standards offers the possibility to examine the scientific grounding of standards in a systematic and generalized way.

3 Standards as Design Science Artifacts

Related to Q1 we want to show how researchers can conduct research about standards in order to evaluate its scientific grounding. Hence, to do so two epistemological paradigms can be differentiated: the design-oriented paradigm and the behavioral paradigm (March & Smith 1995, p. 253ff, Becker & Pfeiffer 2006, p. 3f). The design-oriented paradigm aims towards the development of useful IS solutions by creating and evaluating different artifacts. Whereas the behavioral paradigm deals with the analysis of the effect of these IS solutions on enterprises and markets (Wilde & Hess 2007, p. 281). Based on the described standards development approaches it can be derived that standards are the result of a design process themselves. Therefore, they have to be regarded in terms of design-oriented paradigms.

3.1 Design Science Framework by Hevner , March and Park

The IS research framework of March and Smith (1995) and its refinement, the design science framework of Hevner, March and Park (2004) appear applicable for this investigation. The objective of these authors is to describe the design-oriented paradigm by using a conceptual framework and to provide clear guidelines to evaluate the quality of this research. The guidelines of the Design Science Research Framework (DSRFr) (see table 3) describe the artifact construction and can be used to examine the scientific grounding of an artifact (Hevner et al. 2004, p. 75).

#	Guideline	Description
1	Design as an artifact	a viable artifact (construct, model, method, or instantiation)
2	Problem relevance	a technology-based solution to important and relevant problems
3	Design evaluation	demonstration via well-executed evaluation methods
4	Research contributions	clear and verifiable contributions, design foundations, and methodologies
5	Research rigor	use rigorous methods during design-science research
6	Design as a search process	reach desired ends while satisfying laws
7	Communication of research	must be presented effectively to the audience

Table 3: Guidelines of the DSRFr (Hevner et al. 2004, p. 80ff)

With the fulfillment of these guidelines an artifact can be seen as scientifically validated knowledge. Thus, the designed artifact enters the so called knowledge base, which represents the available basic scientific knowledge as a foundation for further design-oriented research (Hevner et al. 2004, p. 80ff). This means, in case of research with standards, the standard to be used should be part of this knowledge base. Conversely, a standard enters the knowledge base if the standards development process fulfills the guidelines mentioned above.

Hence, to get an understanding about the nature of a standard in case of design science research it is important to relate the guidelines to the characteristics of a standards development process. According to the first guideline, a standards development process has to produce artifacts (constructs, models, methods, or instantiations). Also, the problem relevance and importance of the produced standard has to be given and refers to the second guideline. According to the third guideline the standard's utility, quality, or efficacy has to "be rigorously demonstrated via well-executed evaluation methods" (Hevner et al. 2004, p. 83). The fourth guideline underlines the importance of a clear and verifiable contribution. According to the fifth guideline a standard to be considered a design science artifact needs to be constructed and evaluated via scientific methods. The sixth guideline requires standards development to be an iterative search process and finally the last guideline requires that the artifact has to be published to technology-oriented as well as management-oriented audiences.

In the following section we use the discussed guidelines of Hevner et al. (2004, p. 83) to examine an exemplary standard. We have chosen the XML based reporting standard XBRL.

3.2 Mapping XBRL and its development process against design science guidelines

The eXtensible Business Reporting Language (XBRL) is an IS standard to facilitate communication of business information intra- and inter-organizationally. XBRL does so by the elimination of the semantic gap in business reporting (Debreceny & Gray 2001, Cohen, Schiavina & Servais 2005). The standard is the result of a development process within a consortium, XBRL International (XII), based on the eXtensible Markup Language (XML), a semantic format to provide information, and consists of a family of specifications (Debreceny et al. 2009). Members of the consortium come from several countries and different constituencies of the information value chain. The involvement of software vendors, audit companies, financial institutions as well as international and national standard setters and public entities demonstrate the acceptance of XBRL worldwide.

As mentioned before, XBRL was developed and diffused by an international consortium (XBRL International). Thus XBRL is a consensus-based standard. However, very often, XBRL is called a de facto standard, too. This can be tracked down to the earlier development stages where the complex environment and the lack of transparency in financial reporting was the initial spark for many filers to create a simple reporting method (Kernan 2009, p. 4f). Currently, the Security Exchange Commission (SEC) mandated XBRL as standard for financial reporting in the US (Clemmons 2009, p. 16). Because of this binding mandate, the SEC as a supervisor is interested in the development of a secure and useful standard. Therefore, XBRL reaches de jure status, too. Nevertheless, the ongoing development process is still a consensus-based one. We chose XBRL for our analysis as it is possible to gain a very deep insight into its development process and as it is a widely-adopted, practically relevant and technological standard. Additionally, we want to conduct design-oriented research on the basis of XBRL and thus for the purpose of our own research we need to assess its scientific grounding.

In the following, we exemplarily mapped XBRL against the design science guidelines. As this mapping is prone to subjective judgment we included several review iterations among the papers' authors and an extensive discussion of each guideline. The results are shown in table 4 and are discussed in the following with the guideline number preceding the respective argumentation.

#	Guideline	XBRL	Sources
1	Design as an artifact	✓	Baldwin, Brown & Trinkle 2006, p. 98ff
2	Problem relevance	✓	Debreceny & Gray 2001, p. 62f
3	Design evaluation	✓/o	http://www.xbrl.org, http://groups.yahoo.com/search?query=XBRL
4	Research contributions	✓	Locke & Lowe 2007, p. 586f
5	Research rigor	o	not available
6	Design as a search process	✓	not available
7	Communication of research	✓	xbrl.org/conferences

Table 4: Mapping XBRL and its development process against design science guidelines

(1/2) At the end of the 90's a vast amount of unstructured financial information could not be digitally exchanged without media breaks. XBRL provided a solution to this relevant problem (Debreceny & Gray 2001, p. 52f). As XBRL is derived from XML, a basic technology, it can be considered an IS related artifact. As it is a language – although domain-specific – it belongs to the groups of constructs. (3) With respect to design evaluation the judgment is more complicated. The current websites of XBRL International (XBRL International 2009) give an overview on all recommended XBRL specifications. Within the development process we find four steps: Public Working Draft, Candidate for Recommendation, Proposed Recommendation, and Specification. A public working draft is a paper for a discussion in the XBRL community. After a careful review and agreement by the community on its content, it will be accepted as a candidate for recommendation. If a paper has the status of a candidate for recommendation it is available for free implementation. Next it gains the so called proposed recommendation status before it becomes a fully recommended specification. Our findings suggest that an evaluation is taking place in each of these stages. The utility and the efficacy are tested within the implementation. Additionally the open source character allows every user to take part in the creation and evaluation process as a member of the different working groups. Work within working groups partly resembles focus group discussions. However, a well defined and rigorous evaluation process, like a formal test case or field evaluations, is missing. Yet, field evaluation might implicitly take place outside the scope of the development process. As many organizations such as financial institutions and businesses applying the standard belong to the consortium their usage experiences are certainly reported back to the working groups. This means that the third guideline is probably fulfilled but somehow outside the scope of the development process and thus is not fully under the control of the standard developers. (4) A research contribution, related to the fourth guideline, describes an additional value to the environment of the artifact. Especially XBRL can help to simplify reporting processes along the financial reporting value chain (Cohen 2004, p. 187f). Thus, we find a clear contribution underlining the additional value of XBRL, as Hevner et al. (2004) state, "research must demonstrate a clear contribution to the business environment, solving an important, previously unsolved problem" (p. 87). XBRL has a technical and business contribution in the specific reporting area. Hence, XBRL meets this requirement. (5) In the case of the fifth guideline our research provides no confirmation for a research rigor. (6/7) Guidelines six and seven can be confirmed in the context of XBRL. The different versions in different years (2000 XBRL 1.0, 2001 XBRL 2.0, 2002 XBRL 2.0a, and 2003 XBRL 2.1) indicate an iterative search process and also the stages within each development cycle already support this notion. When looking at the four versions of specifications there are significant differences in reaction to further requirements during the years of development. As all versions are fully available and as the steps within each development cycle result in still available results, the development process is very transparent with respect to interim results and final versions. Also, the communication of XBRL as a new technology took place on many technical and business conferences and was accompanied by many publications on the part of XBRL International, too (XBRL International 2009).

Summing up, the mapping provides a suggestion on how to examine a special standard with respect to design science guidelines. The XBRL example shows that guidelines exist where researchers have to pay attention if they intend to use this standard within their artifact construction process. Because of the not confirmed rules (e.g. research rigor), we point out that there is a lack of scientific grounding although the development process has obvious similarities with design science research processes.

3.3 Mapping general standard classes against design science guidelines

So far we have shown that a specific standard might not be considered a fully scientifically validated artifact. However, we cannot infer a general conclusion from this example because, as already mentioned, there are many differences between standards development approaches. Accordingly, we conducted another evaluation which does not address the specific standards themselves, but their general development approaches. The classes in table 2 (de facto, consensus-based, de jure) serve as research objects and are mapped against design science guidelines. Table 5 shows the results of this mapping which can be considered a first suggestion for researchers in order to sharpen their awareness as to where major weaknesses are to be expected.

#	Guideline	De facto	Consensus-based	De jure
1	Design as an artifact	✓	✓	✓
2	Problem relevance	✓	✓	✓
3	Design evaluation	o	o	✓/o
4	Research contributions	o	✓/o	✓/o
5	Research rigor	o	o	o
6	Design as a search process	o	✓	✓
7	Communication of research	o	✓	✓

Table 5: Mapping of standards development approaches against design science guidelines

(1/2) Guidelines one and two are equally valid for all classes, because as with XBRL there usually is an artifact as well as a relevant problem the standard aims to address. It is irrelevant whether the development process is driven by market forces (de facto) or an organization (consensus-based, de jure). (3-5) With respect to guidelines three to five, de facto standards cannot be said to meet these requirements. Neither the evaluation nor the research contribution or the scientific rigor can be demonstrated in the creation of a de facto standard. This is not surprising, as there is no regulation or formalization of development, adoption, and diffusion of a de facto standard. (3) For consensus-based standards, the same reasoning as for XBRL can be adopted. Our investigation showed that consensus-based standardization consortia have no established and transparent evaluation criteria within the standards development process although some sort of field evaluation is likely to take place under the control of individual community members (ISO 2004a, OMG 2009, W3C 2009). (3) In contrast to the consensus-based standards, some de jure standards organizations provide evaluation guidelines. Although no demonstrable evaluation criteria are available, but for example the DIN uses defined procedures during the development process (DIN 2009). That is the reason why we see a difference to the consensus-based standards and we partly approve the third guideline. (4) The fulfillment of the fourth guideline cannot be confirmed in general. As with XBRL consensus-based standards can deliver a relevant contribution in a specific area. But this fact has to be checked for every consensus-based standard individually. The evaluation of de jure standards follows this. (5) With respect to the fifth guideline we cannot confirm research rigor in both cases, consensus based and de jure standards. (6/7) Since de facto standards are created by market forces and this process is more or less uncontrolled, we cannot expect a transparent search process. Furthermore the communication of the result happens by chance and therefore cannot be confirmed either. For consensus based and de jure standards different versions with various statuses exist. Hence, a search process is part of the development process for both. The communication of consensus-based as well as de jure standards is available to the audience by specific journals, documentations, websites, conferences or even laws and regulations.

4 Consequences for Researchers

As described above we see that standards usually lack a full scientific grounding and thus must not be automatically included in the scientific knowledge base (Hevner et al. 2004, p. 80). However, as mentioned in the introduction de Vries (1999) and Jakobs (2003) see a strong necessity to do research with standards and this calls for standards as part of the knowledge base. Hence, a gap between the needs of IS researchers and the requirements on the used knowledge exists, because the knowledge, which is used for designing an artifact has to be derived from the knowledge base in order to make the artifact rigorously researched and vice versa (Hevner et al. 2004, p. 94ff). Recent literature addresses this gap as well. Zelewski (2007) for example mentions that Hevner et al. (2004) miss to provide a clear methodology for creating an artifact. He also criticizes that Hevner et al. (2004) do not explain in detail how knowledge is accepted into the knowledge base. It is not explained whether there are other sources of knowledge than scientific results (Zelewski 2007, p. 90f).

In reaction to another scholarly discussion (see Iivari (2007)) Hevner (2007) adapted the design science process and emphasizes that knowledge within the knowledge base does not necessarily need to be generated through scientific research. The so called “additional knowledge” is an important part of the knowledge base as well. This additional knowledge comprises “experiences and expertise that define the state-of-the-art in the application domain of the research" and consists of existing artifacts and processes of the area of application (Hevner 2007, p. 89). Thus, standards can be part of the knowledge base, since they may represent additional knowledge of this type. But with this additional explanation the DSRFr becomes less consistent. The possibility to use any item as a foundation for research may cause a loss of research rigor as shown by the investigation above. Hence, our suggestion is that a researcher has to be careful while using a standard as a method or construct during the design science process and is responsible to assure research rigor. This has two consequences for the researcher. First, using additional knowledge in research without scientific grounding weakens the researcher's own results. Second, there might be a risk to fail the research aim. In order to avoid this risk the researcher should validate the knowledge he intends to use with respect to its scientific grounding (Hevner 2007, p. 90). For research with standards this might imply that the researcher evaluates the standard in terms of the design science rigor cycle (Hevner 2007, p. 89). For doing this we suggest three evaluation levels. These levels are related to the dependencies between the scientific grounding of foundations or methods, the DSRFr, and the classification of development approaches of standards.

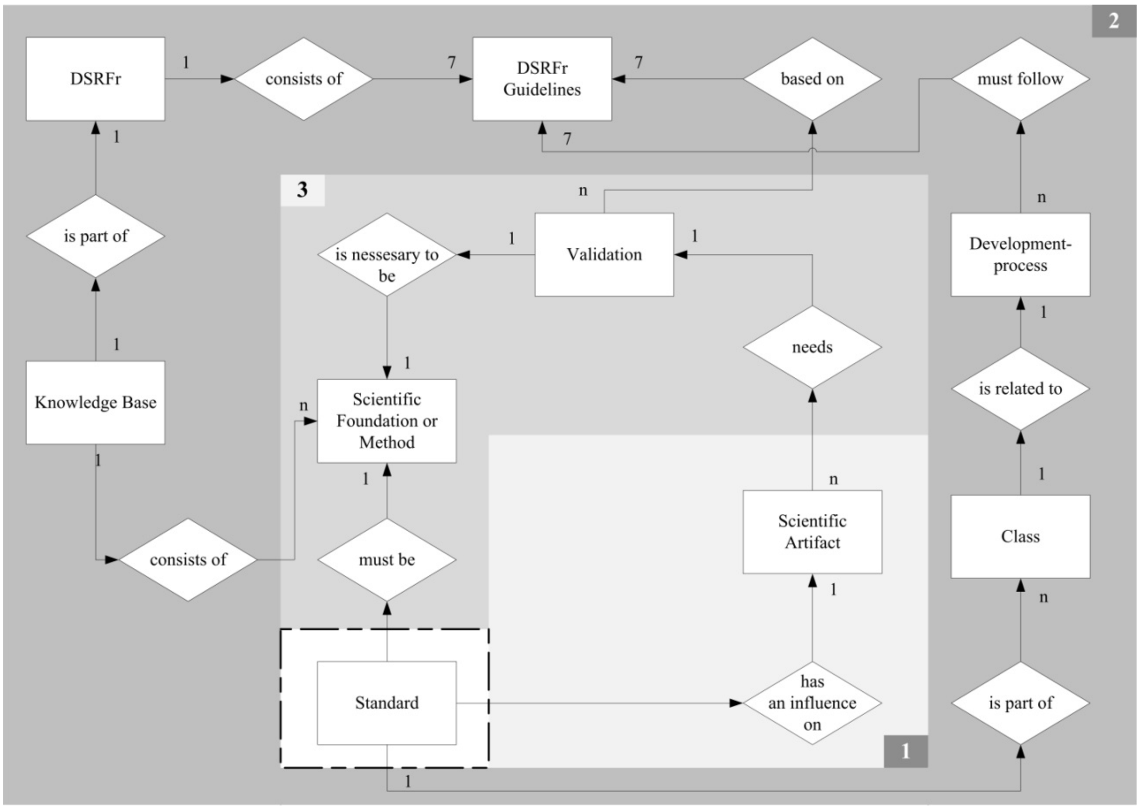

Figure 1: ER-M of the three evaluation levels

Figure 1 shows an Entity-Relationship-Model (ER-M) of the stated dependencies. At the first level the influence of the used standard is the object of the evaluation. At least, the influence is a critical aspect to decide, whether a standard has to be validated or not. If the standard has a low influence on the artifact to be developed, then there is hardly any need to validate a standard as a scientific artifact. If the used standard is rejected as a scientific method or construct, the designed artifact still may be scientifically grounded if the qualities and characteristics of the artifact do not depend on the use of the standard. If a standard has a significant influence, the evaluation process reaches the second level. The goal of the second level is to show to what extent the standard meets the requirements as stated in the design science guidelines. By mapping the design science guidelines the researcher becomes aware of the critical guidelines and the weaknesses in the scientific grounding of the standard. As a starting point we provide the standard classes and their class based mapping (Table 5) in order to guide the researcher to those guidelines he or she needs to pay most of his attention too. Next, at the third level, the researcher has to verify every critical guideline which means checking the critical guidelines on the basis of a detailed analysis of the underlying development process in order to evaluate its scientific grounding. The result of the third level analysis can be, first, a confirmation of the critical guidelines which allows the researcher to use the standard without threatening the research rigor of his own research process. Second, the confirmation as a scientific artifact may fail. Hence, the artifact cannot move into the knowledge base and should not be used as foundation or method. Third, because of a rejection, the researcher has to argue why the critical guidelines are obsolete or irrelevant for the designed artifact or what he or she did himself to improve the standard's scientific grounding if the standard should be used.

5 Conclusions and Outlook

Along with increased standardization activities in the field of IS, the importance of research for and about IS standards steadily increased. Furthermore many researchers are using IS standards as components or even as foundation for other research projects, especially in design-oriented research. However, there is hardly any discussion available in the literature on the prerequisites and restrictions when researching with IS standards in design science projects.

We took up this issue, investigating the scientific grounding of IS standards. According to our research question Q1 and Q2, we have shown that at least de-jure and consensus-based standards are artifacts apt to be assessed on the basis of their development processes. To illustrate this we have conducted an exemplary assessment of a consensus-based standard called XBRL. Our findings imply that IS standards can be developed through different approaches with the main difference being the existence of well defined development and evaluation processes. These differences affect the suitability of an IS standard as a component or basis of design-oriented research. While mapping the standards development approaches against the guidelines of the DSRFr of Hevner et al. (2004), we illustrated that every approach shows weaknesses from a scientific point of view and that for each type of standard we have critical areas where they might fail a positive assessment. To answer Q3, our results show that especially the (scientific) evaluation and the research rigor are the most critical issues. In case of de facto standards the iterative search process and the communication of the results are missing, too. Furthermore, our research reveals, that de jure standards tend to be most likely accepted as scientific components within design-oriented research. However, consensus-based standards fulfill most of the guidelines, too. Therefore they have to be evaluated accurately.

Summing up, none of the standards development approaches was able to fulfill all of the guidelines. But although the scientific grounding of an IS standard has to be questioned, we do not want to inhibit research with IS standards. Our aim rather is to sharpen the awareness that IS standards must not simply be considered as naturally belonging to the scientifically grounded knowledge base. Due to the existing weaknesses every IS standard has to be evaluated individually before using it for research. The scientist has to clearly point out the relation between the designed artifact and the used standard and scientific restrictions emerging out of the characteristics of the standard should be addressed explicitly.

Future research should map the characteristics of standards and standards development approaches with other scientific frameworks. The more explicit and detailed a framework is the more prescriptive the results of such a mapping will be. Furthermore the classification of standards development approaches should be refined in order to provide more detailed results. Both aspects will help researchers to derive more specific assistance on how to enhance a standard's scientific grounding.

Finally, the problem covered in this paper can be generalized to the level of any type of artifact, be it a standard or not, intended to be used in design science research. We have chosen to start with standards because they are likely candidates for artifacts constructed in development processes with obvious similarities to design science processes. Additionally, these processes have a chance of being transparent to outsiders. Thus they at least offer the potential to be assessed with respect to their scientific grounding via looking at their development processes. Many other artifacts do not offer this potential. Yet, generalizing our argumentation to any type of artifact should be a next step. Assuming that assessing artifacts of any type may require considerable effort we suggest that a more detailed approach is needed in order to decide which of the artifacts used in a design-oriented research project should undergo an assessment of their scientific grounding. Therefore, our next step is to define a respective decision model that helps guiding the individual researcher on which of the potential artifacts to focus.

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