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Towards a document-driven approach for designing reference models: From a conceptual process model to its application

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ABSTRACT

In IS research, reference models have demonstrated to be a beneficial instrument for providing blueprints for a reasonable, good design of information systems and underlying organizational settings. Researchers assume that the application of reference models allows time savings, cost savings, and quality increases. But these effects may only appear when providing a research-based and empirically evaluated reference model that is profoundly documented. However, research criticizes the often missing identification of similarities in related work and preexisting knowledge, which might lead to arbitrariness. Moreover, linking existing knowledge during development and evaluation processes of reference models can bring new and fruitful insights. Therefore, this paper uses a scientific approach consisting of four steps. First, we develop a requirements framework for designing reference models. Second, we use this framework as a basis for the comparison of well-documented reference models. Thereafter, the gained insights from step one and two are consolidated into a conceptual process model that has a strong regard to preexisting knowledge. Finally, a case study will show the applicability of the determined model. With this paper, we enrich research by a valuable guideline for developing methodologically well-designed reference models that support users to take full advantage of the above mentioned benefits.

1. Introduction and motivation

Conceptual information models constitute important artifacts within the domain of information systems (IS) research and have been studied by scientific institutions and by practice (e.g., Chen, 1976; Scheer and Hars, 1992; Cash and Wilkerson, 2003; Keller and König, 2014) for many decades. With the development of information models, the intention is to build manageable artifacts that enable decision makers to understand the complexity (Thomas, 2006) and to increase the transparency of the underlying IS processes (Becker et al., 2010). For the adoption of information models, there are various areas of application, ranging from initial software development to advanced business process reengineering. Thereby, conceptual information models reconstruct a piece of reality.

The paper at hand focuses on one specific type of conceptual information models, namely the reference information model or *reference model* (RM) to use the more common term. In general, RMs have their origin in the need for creating an abstract of in-depth company or project-specific IS in order to reuse this abstract in other applications or to transfer it on other environments (Frank, 2007). According to Thomas (2006), a RM always constitutes an initial model as a point of reference for the construction of other and more specific models. Such an initial model promises the model users time savings, cost savings, and quality increases (Fettke and Loos, 2005). In spite of these advantages, research still struggles with providing a common understanding of RM. Furthermore, research literature argues that reference modeling may consist of specific IS methods, IS languages, and IS tools. But these specifications vary from author to author, which leads to a broad fluctuation range within the RM paradigm.

However, it is common sense that the effectiveness and efficiency of the application of a RM is strongly determined by the quality of the initial RM. In order to be able to properly translate the model and to ensure clear model guidance, according to Thomas (2006) and Becker et al. (2010), there are two basic quality conditions: an adequate *degree of universality* and an adequate *degree of recommendation* for the users. But it is unclear how these quality characters can be verified. Vom Brocke (2003), Fettke et al. (2006), as well as Möller et al. (2011) discover a lack of assessability for the content of universality and recommendation in RMs. In this regard, Thomas (2006) as well as Fettke and Loos (2004) motivate scientific research to provide adequate approaches for measuring and evaluating the quality of RMs, as operational and practical users are not in a position to assess the universality and recommendation quality of suchlike models. To be more precise, Fettke and Loos (2003) also refer to the research outcome

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"reference model" that can be understood as a theory in the IS area. Hence, it is indisputable that the construction of RMs should strongly and systematically be based on already existing knowledge. This strong knowledge regard (e.g., involving research in science and practice, expert knowledge) constitutes the starting point of our paper, as we intend to meet both conditions (universality and recommendation) in a document-driven way. Stating very clearly, the purpose of our work is not to call into question the valuable outcomes of existing RM research. Moreover, we believe that there cannot be a one-way-fits-all approach on the complex domain of RM research. Thus, we strive to contrast with the other already existing and well-known conceptual models for designing RM (e.g., Fettke, 2005; Vom Brocke, 2003). Given a rich knowledge base, we intend to provide a document-driven process model that might bring new insights for RM developers and users by linking the RM to the underlying body of knowledge. Herein, document-driven means that the design process of RM is in addition to the modeler´s subjective intuition or personal experience effectuated by documents´ contents (e.g., scientific and practical literature, transcripts of expert interviews, postings in social media networks).

Moreover, our paper goes in line with the argumentation of the recently developed research on inductive RM development (e.g., Ardalani et al., 2013, Martens, et. al. 2014, 2015) by stating that the *identification of similarities* between already existing knowledge is compellingly needed for deriving abstracted RMs in order to meet the above mentioned two conditions. Towards this end, statistical analysis and data mining constitute important RM development and evaluation methods for enabling a higher level of objectivity and for reducing arbitrariness. In classic research on RMs, only few authors of such RMs reveal the procedural methodology with which they developed and evaluated the presented models. This leads to models that are only loosely anchored in scientific literature and practice knowledge. Fettke and Loos (2004) consider it essential to perform the evaluation and assessment procedure already during model creation and not only at the final phase, since this is the only way to enable an iterative creation and evaluation process. Therefore, we aim to present a more complex RM design life cycle that involves related knowledge by a metric-based evaluation. The underlying research questions (RQ) of this paper are as follows:

RQ1: What characteristics of a conceptual process model are necessary for the design and evaluation of RMs that are, contrary to many already existing RMs, deeply anchored in related knowledge?

RQ2: How can objectivity be ensured and arbitrariness be avoided during the design and evaluation of RMs?

In terms of the paper's structure, we adopted Becker et al. (2009) who provided a general procedure model for the development of maturity models, while criticizing preexisting arbitrariness in model development as well. In Section 2, we explain the relevant theoretical background, which leads us to the general requirements of reference modeling. In Section 3, we use the determined requirements as a basis and compare various selected RMs. Thereafter, we extend the existing body of knowledge by presenting the conceptual process model for the development of RMs. In Section 5, we experimentally apply the model on the topic of cloud usage in supply chains. The paper ends with a conclusion in Section 6.

2. Theoretical backgrounds

2.1. Related work

The synthesis of the reference modeling research field has brought much valuable insights to the existing body of knowledge. Within this section, we focus on research that discusses procedures and approaches for designing RMs (*research methodologies*), whereas the analysis of finished RMs, as an aid for end users (*research outcomes*), is covered in Section 3. For identifying relevant work, we used two scientific databases (Science Direct, Springer Link) and the following searching terms: (reference model OR reference modeling) AND (methodology* OR research). Moreover, we took only publications from the year 2000 and ongoing into account as we were interested in the latest research progress, assuming that prior work (< year 2000) was implicitly involved in the latest research. Further, the term reference model has widely been used with different meanings. Therefore, we took only papers that go in line with our understanding of the term (cf. Section 2.3) and focus RM methodologies and/or procedures instead of RM applications (research outcomes). In the next step, we excluded papers that show only minimal additional contribution to existing literature (e.g., proceedings´ papers similar to extended journal papers of the same authors or similar papers in different languages). Herewith, we got 16 relevant papers.

Hence, we have identified important studies that could, despite of some significant differences, be compared to ours. These 16 studies are summarized in Table 1 and compared to our approach according to the following attributes:

- Semantic approach: Does the study provide any ontology to analyze RM processes?
- Literature regard: Does the study compare related work?
- Evaluation: Does the study discuss an evaluation approach and, if so, is there a new evaluation approach determined?
- Major issue: What is the problem domain of the study and what is the main difference between this approach and ours?

Looking at Table 1, which contains studies of some of the most influential researchers on RM development, it is obvious that research on RM covers a quite broad range and includes various semantic approaches, evaluation methods, and IS issues. Furthermore, there are various papers that discuss general guidelines in RM development, and hence, seem to be similar to our study. Our paper distinguishes from the existing literature by two main aspects: (i) there is no paper on RM research that discusses the RM development and evaluation from a business process modeling notation (BPMN 2.0) perspective, which would enable an intensive analysis of the RM developer and the RM user role; and (ii) there is no metric-based RM evaluation presented. Highly depending on the amount and the quality of the underlying documents, this evaluation phase might bring novel insights by analyzing RM contents in preexisting knowledge (e.g., testing the discussion intensity in documents of specific connection points in the RM). The recently created metric-based approaches by Ardalani et al. (2013) and Martens et al. (2014, 2015) are helpful especially for *inductive RM development* of individual projects, while (by nature) allowing a high degree of encapsulation from existing adjacent knowledge. In contrast, the metric part of our approach focuses particularly on the *RM evaluation processes* and allows virtually inductive (e.g., involving transcripts of expert interviews around one common process) and deductive (e.g., involving practice research and/or scientific theories) evaluation. But although a large part of the referenced papers have a related work section (literature regard), most of the approaches have been developed independently from each other, which is criticized by Becker at al. (2007) and Vom Brocke et al. (2014). With our approach, we aim at a comprehensive involvement of related work during the whole RM creation process.

2.2. Characterization of knowledge involvement

The Oxford dictionary defines knowledge as awareness or familiarity of facts, information, or skills, which are gained through experience or education; the theoretical and practical understanding of a subject. Hence, knowledge may be documented in various forms such as scientific and practical literature, social networks or transcribed