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### Discourse-Orientation in Conceptual Model Quality Research -Foundations, Procedure Model and Applications

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Publications of the Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI)

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# Abstract

Conceptual models have gained tremendous importance for the Information Systems (IS) discipline in recent years. As the quality of conceptual models plays an important role for their practical benefits, different approaches for systematic model quality evaluation have emerged. These approaches, however, are often based on different notions and conceptualizations of model quality. In this contribution, we refrain from conceptualizing and operationalizing model quality *a priori*. In contrast, we assume that the determination of model quality and appropriate quality criteria has to be negotiated in a discourse between modelers and model users based on their different perspectives. Following this assumption, we present a procedure model and a software prototype for the (re)construction and evaluation of conceptual model quality discourses. Exemplary applications of this procedure model and the software prototype show that discourse-orientation can significantly contribute to a better understanding of different model quality notions and requirements and can, thus, support quality improvement of conceptual models.

**Keywords:** Model Quality, Discourse-Orientation, Conceptual Modeling, Model Understandability, Quality Discourse

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# List of abbreviations

AML	ARIS Markup Language
ARIS	Architecture of Integrated Information Systems
BPMN	Business Process Model and Notation
BPEL	Business Process Execution Language
BWW	Bunge-Wand-Weber Model
CMQF	Conceptual Modeling Quality Framework
CSCW	Computer-Supported Cooperative Work
DFKI	Deutsches Forschungszentrum für Künstliche Intelligenz
EPC	Event-driven Process Chain
EPML	Event-driven Process Chain Markup Language
Fig.	Figure
GOM	Guidelines of Business Process Modeling
IS	Information Systems
ISR	Information Systems Research
IT	Information Technology
IWi	Institute for Information Systems
JAIS	Journal of the Association for Information Systems
MISQ	Management Information Systems Quarterly
RQ	Research Question
SEQUAL	Semiotic Quality Framework
Tab.	Table
UML	Unified Modeling Language

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## 1 Introduction

In research as well as in practice, conceptual modeling is considered an important tool for designing enterprises and organizations. Furthermore, conceptual models are indeed used in a growing number of organizations (Fettke, 2009) and they are commonly regarded as valuable methodical instruments for engineering and maintaining information systems (IS) (Germonprez, Hovorka, & Gal, 2011). Conceptual models offer application potential in fields such as business process management, software engineering as well as for the choice, implementation and customization of standard software. Conceptual models can, however, only fulfil their important function if they are of an adequate quality as model quality can have significant influence on the success and efficiency of IS engineering projects (Krogstie, Sindre, & Jorgensen, 2006). Therefore, questions concerning model quality are of high significance for IS engineering research and practice (Nelson, Poels, Genero, & Piattini, 2005).

Existing contributions in this field of research indicate that conceptual model quality is often differently conceptualized and operationalized (Moody, 2005). In previous discussions, the importance of model quality for IS research, software engineering, and further scientific disciplines has been stated. Furthermore, it has been acknowledged that model quality is typically assessed and evaluated differently depending on the views and perspectives of the different stakeholders (Lindland, Sindre, & Sølvberg, 1994) like modelers, model users etc. Thus, different notions of model quality exist. In fact, the term quality is often used as an umbrella term which subsumes a plethora of different understandings depending on the intended context of conceptual models' usage. This is why there have been several attempts to systemize the different facets of the term "model quality" by means of quality frameworks, e. g. the semiotic quality framework by Lindland et al. (1994) or its revision called SEQUAL by Krogstie et al. (2006) which can be regarded as being among the most influential quality frameworks in modeling research. Although these approaches have been constantly further developed and provide a very good "understanding of quality in modeling" it has been acknowledged that a certain "disability to facilitate precise, quantitative evaluations of models" is still given for SEQUAL (Krogstie et al., 2006) (p. 101). This has to do with the fact that "only syntactic quality (of the levels in the original framework) [.] has any hope of being objectively measured, as both the problem domain and the minds of the stakeholders are unavailable for formal inspection" (Krogstie et al., 2006) (p. 94). This problem has to a certain extent been treated during the revision of SEQUAL. However, one cannot be sure that every possible view and perspective of all stakeholder of a conceptual modeling project are comprised and, furthermore, that all potential quality claims have been considered by such a *top-down* framework. Against this background and taking other model quality contributions in IS research into account it has to be concluded that the term *model quality* still remains ambiguous as well as its specific characteristics and facets and, moreover, how they can be precisely measured. We argue that simply using general and *a priori* defined model quality criteria – which are mostly provided by top-down model quality frameworks – for model evaluation without considering specific situations or relevant views and perspectives of stakeholders seems to be problematic. This problem is equally valid for both research and practice.

Our article aims at overcoming this problem presenting a discourse-oriented approach for model quality evaluation which is supposed to serve for a *bottom-up* development of a specific and shared model quality understanding. Our contribution aims at answering the following research questions:

**RQ1**: How can a comprehensive model quality assessment be conducted under consideration of all stakeholders' perspectives and quality claims?

**RQ2**: How can discourse-orientation help to develop a more precise quality understanding as well as adequate and valid quality metrics?

**RQ3**: How can discourse-orientation support cumulative research in Conceptual Modeling and Information Systems in general?

In our approach, model quality criteria are not *a priori* conceptualized and operationalized. In contrast, it is assumed that the notion of model quality and determination of quality criteria are negotiated in a discourse between modelers, model users and evaluators. In such a discourse, different views and perspectives regarding requirements as well as methods for the measurement and improvement of model quality can be discovered and serve for a *bottom-up* development. Investigating and documenting these views and perspectives is important to gain a comprehensive understanding of model quality, which is highly desirable from the point of view of *cumulative research*. Discourse-orientation can help to develop and choose adequate quality criteria for the evaluation of conceptual models in certain situations. Against this background, a procedure model for the (re)construction and evaluation of conceptual model quality discourses is developed which can support both the (1.) *identification of model quality factors and* 

*criteria* as well as the (2.) *usage of the identified model quality factors and criteria for concrete model quality assessment and validation* (Frederiks & van der Weide, 2004). Although our procedure model can be considered a rather research-oriented approach in the first place, it can nevertheless help to improve model quality in practice, too. In the remainder of this paper, furthermore, a software prototype supporting the different steps of our procedure model is presented as a proof-of-concept.

Besides conceptual argumentation and analysis, this contribution uses a *design-oriented research approach*. At first, we analyse related work on conceptual model quality. Thereafter, the conceptualization of models and the role of language in conceptual modeling are investigated in order to justify the development of our procedure model and our according proof-of-concept prototype. Furthermore, we investigate the feasibility and usefulness of our procedure model and prototype by means of different exemplary applications.

This contribution has the following *structure*: after this introduction, the second section presents related work in the field of model quality research. In the third section, the conceptualization of models and the role of language in conceptual modeling in general are treated in order to justify and explain the potential of our discourse-oriented approach. Section four discusses the general potential of discourse-orientation for conceptual model quality research and introduces our procedure model for the (re)construction and evaluation of conceptual model quality discourses. Then the two following sections describe *how* the procedure model can be applied in different scenarios:

- 1. An exemplary application of our procedure model for the *reconstruction of the scientific model quality discourse* on model understandability in literature is presented in section five in order to demonstrate its feasibility and usefulness for research.
- 2. Then in section six, the proof-of-concept software prototype supporting the different steps of our procedure model is introduced and exemplarily illustrated in the context of *an initial construction of a model quality discourse in practice*.

Section seven discusses the findings before section eight concludes the contribution with a summary and outlook on planned future research. This paper is a comprehensive revision and extension of the content of two conference papers: (Fettke, Houy, Vella, & Loos, 2012) and (Houy, Fettke, & Loos, 2012). Furthermore, a new software prototype

supporting our introduced procedure model is presented. Additionally, a stronger foundation and justification of discourse-orientation in model quality research is given based on the extended and revised findings presented in (Fettke, Vella, & Loos, 2012).

# 2 Related Work on Conceptual Model Quality

Conceptual models are valuable instruments for the clarification and documentation of the meaning and relationship of terms and concepts in a domain in order to support communication during the development of information systems (Wand, Storey, & Weber, 1999). In this context, models are important artefacts especially for the design and maintenance of IS as they support the documentation of IS functionalities and structures (Wand & Weber, 2002). In general, questions concerning model quality are of high significance for IS engineering as models can only fulfil their function if they are of an adequate quality (Nelson et al., 2005; Nelson, Poels, Genero, & Piattini, 2012).

However, the term *model quality* has not been consistently defined in literature. In general, it comprises and describes characteristics, properties and conditions of a conceptual model. In literature, different types of approaches for the conceptualization of model quality can be identified. One classification of model quality approaches is related to the models' *purpose* and contains the following types of approaches (Garvin, 1984): transcendent, product-oriented, application-oriented, creation-oriented, and value-oriented approaches. Depending on the type of approach, different quality aspects and dimensions are relevant for the conceptualization of model quality; e. g. application-oriented approaches focus on usability aspects for model users, while creation-oriented approaches consider characteristics of conceptual model construction processes. Furthermore, a spectrum of approaches for the conceptualization of model quality related to the *covered views and perspectives* on model quality have emerged in literature (Moody, 2005):

1. *View-specific approaches*: several contributions discuss single or one-dimensional quality requirements regarding conceptual models. In most cases, these contributions refer to specific modeling methods, which justifies classifying the presented approaches as *view-specific*. Furthermore, dedicated quality criteria for data models on the one hand (Moody, 1998) and process models on the other hand (Krogstie, Sindre, & Jørgensen, 2006) can be distinguished. Today, the number

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of existing approaches regarding data models is considerably higher than for process models.

- 2. View-combining approaches: Several reference frameworks aim at integrating different model quality aspects which are independent of modeling methods and techniques. This allows for classifying them as view-combining approaches (Frank, 2007). Well-known examples are the Guidelines of Business Process Modeling (GOM) (Becker, Rosemann, & von Uthmann, 2000) or SEQUAL (Krogstie et al., 2006). Special variants of the GOM are discussed, e. g., by Janiesch et al. (2005). Recently, Nelson et al. (2012) have introduced the so called Conceptual Modeling Quality Framework (CMQF) which extends the quality framework by Lindland, Sindre, and Sølvberg (1994) combining it with the Bunge-Wand-Weber (BWW) model (Wand & Weber, 1990).
- 3. *Design-related suggestions for conceptual modeling*: Selected contributions offer specific design-*related* suggestions on *how* model quality can be increased. In these contributions, the topic of model quality determination is often merely indirectly addressed. Related linguistic approaches can be found, e.g. in the article of Ortner et al. (1996).

This variety of different conceptualization approaches and their notion of model quality show that model quality has been quite differently defined, conceptualized and operationalized. The investigated types of frameworks cover numerous different, interesting dimensions of model quality and propose valuable instruments for the measurement of model quality. Furthermore, some contributions with explicit validations of quality measurement instruments exist such as those by Moody (2002b), Moody et al. (2003) and Sedera et al. (2002).

However, against the background that subjective notions and perspectives can have significant influence on the perception of conceptual model quality (Ågerfalk & Eriksson, 2002, 2004; Recker, 2007) – which we will elaborate in more detail in the following section – it seems to be almost impossible to *a priori* conceptualize and operationalize model quality in a way that fits every possible view or perspective.

# **3** On the Role of Language in Conceptual Modeling and the Conceptualization of Models

Conceptual models – as a *tool* for enterprise and IS design or as theoretical objects of research – are not simply "given" like a pebble found at the shore which can be used by a human as a *tool* for driving a nail into a wall. In contrast, conceptual models are always related to language. In fact, they cannot be thought without language. Their creation and interpretation are always connected to and depend on a person's mind and mental states while other objects, like the pebble lying at the shore, exist independently of a mind. In connection with that, language is needed to explicate the content and structure of a conceptual model. This is equally valid for the field of business process modeling. Besides *informal* process descriptions in natural language ("free prose") (Markovic, 2010), several types of "languages" with different degrees of formalization can be used for the representation of business processes (Desel & Juhás, 2001):

- Technical drawings: Process models can be represented by means of defined graphical elements and symbols with a standardized meaning. This was a first step towards the formalization of process modeling languages. *Event-driven Process Chains* (EPC), the *Business Process Model and Notation* (BPMN) or *UML Activity diagrams* can serve – besides other purposes – for graphical business process modeling.
- 2. Mathematical structures: Process models can, furthermore, be represented by means of mathematical expressions and structures based on set theory or first-order logic in order to communicate the content of a process model in a formalized way. Even though such mathematical structures provide further formalization of business process models, they need to be machine readable. Thus, formal languages are needed which constitute the third class of languages for business process representation.
- 3. Formal languages: Process models can be represented by means of formal languages according to the common understanding of the field of theoretical computer science. A formal language in the sense of theoretical computer science is a finite set of strings of symbols (Davis, Sigal, & Weyuker, 1994). Formal languages can support different purposes: (1) the provision of a machine-readable representation of process models in order to make them inter-

changeable, such as the *Event-driven Process Chain Markup Language* (EPML) or the *ARIS Markup Language* (AML) for EPC models, and (2) the provision of a machine-readable representation of a process model in order to make them executable by means of a process engine.

Figure 1 gives examples for the mentioned language classes for process representation.



Fig. 1: Languages for the representation of an EPC

Additionally, the relationship between conceptual models and language affects different levels, as is shown by some easy example EPCs in figure 2. The structure of these five EPCs can easily be interpreted by machines because a distinct definition and mapping of graphical model elements onto a machine-readable language exists. However, the mere perspective on a model's execution semantics is surely not sufficient, which is illustrated by the models 2) to 5) in figure 2. Their labels represent specific content expressed by natural language, which can hardly be interpreted by machines. Model 2) and model 3), e. g., represent different perspectives – buyer and seller perspective – of one business process although they have exactly the same structure. Furthermore, the models 4) and 5) *could* or *could not* express the same content as model 3). This does not become clear from the models themselves. In the case of model 4) the process is formulated with a different terminology. In order to make sure whether exactly the *same* process is represented it has to be further clarified whether the used terms really mean exactly the same to the stakeholders interpreting and using this model. A further problem is illustrated by means of model 5) which has been formulated in a different

natural language. For people understanding a foreign language (in our example German) it could on the surface seem that this process model represents exactly the same content as model 3). However, as language is always culture-bound, the words used in labels of models always have to be interpreted considering the underlying culture-related notions. There can be large differences between the interpretations of certain words or concepts when comparing different culture areas.



Fig. 2: EPCs with and without descriptive labels, according to (Fettke, Vella, et al., 2012)

The fact that the labels' content is of highest importance for the model is equally valid for other process modeling languages as well as for data modeling. Thus, natural language itself has tremendous importance for a complete understanding of conceptual models apart from their structure or executions semantics. Modeling as well as the act of reading and understanding models are connected with certain presuppositions and notions. Hence, conceptual models and the contained information are language- and culture-related artefacts which are constructed by subjects (Recker, 2007). As a result, models can also be interpreted differently depending on subjective "mental states" and the language used by a person who is creating or interpreting a model. We will explain this in more detail in the following.

In IS development projects, conceptual models are usually created by several different modelers. The various subjective notions and the modellers' experiences can have a significant influence on the resulting models. Against this background, models can differ depending on the modeler – as stated above – mainly regarding two different aspects: (a.) the use of the different elements of a modeling language and (b.) the manner of representing real-world circumstances using textual expressions in free prose in the labels of a model.

Ad (a.) The first mentioned aspect strongly depends on the conceptualization and the standardization of modeling languages. Sometimes the degree of freedom concerning the usage of elements can differ, e. g. when EPCs are compared to the current BPMN 2.0 specification. In order to have a clear and consistent notion and understanding of a model, which is highly relevant for successful communication, models have to have a clear conceptualization themselves. However, the conceptualization of models varies depending on what *means* are used (and how) for conceptualizing a model. This *means* is typically some sort of language such as natural language in the form of a text describing a process or the process representation languages mentioned above. However, language itself – just like a model – can *per se* not be understood as a given artefact, which is directly and consistently accessible for everybody. Languages are interpreted by persons based on their own beliefs and ideas regarding what different words or elements of a language exactly *mean* to them. This is the point where ambiguous notions of the content of a model can occur. Although the different elements of graphical modeling languages should be standardized and have distinct meanings, this is not always the case, such as in the case of EPCs. It is commonly known that based on their higher degree of freedom concerning the usage of modeling elements, the content presented in EPCs can be ambiguous (Fettke, Houy, & Loos, 2010; Houy, Fettke, & Loos, 2009). Therefore, education and training concerning the usage of modeling languages also play an important role.

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Ad (b.) Another aspect that can make a difference between conceptual models depending on the modeler is related to the textual expressions which describe the model content and which are typically presented in the labels of models' nodes. In this context, the problem of synonymy, homonymy or the labelling style resulting in ambiguous notions of a model's content has been investigated in literature, e.g. in (Fettke, Vella, et al., 2012; Leopold, Smirnov, & Mendling, 2009, 2011; Mendling, Reijers, & Recker, 2010). Moreover, subjective notions of a model's content are also strongly related to the use of natural language such as technical terms and, thus, also to the role of a person dealing with a model in an IS project (domain expert, IT expert, method expert etc.). A domain expert's model would most likely present and stress different aspects than an IT expert's model on the same issue. Accordingly, the notions and understandings of the content presented in a model usually differ based on the individual perspective and role of a specific person interpreting a model. This is also the reason why different persons in different roles have different ideas what makes a conceptual model a high-quality model. Hence, subjective notions also have significant influence on the perception of model quality.

Especially against this background, it appears to be problematic to a priori conceptualize and operationalize *model quality* for every possible view or perspective – which is commonly the case with top-down model quality frameworks. On the one hand topdown frameworks offer a valuable general guidance concerning questions of model quality. On the other hand even Krogstie et al. (2006) admit that sometimes underlying assumptions of such frameworks are "too simplistic to assume that [certain ideals] will be the same for every member of an organisation; there will probably be as many different opinions [..] as there are members in the organisation" (p. 98). In order to cope with this problem, our contribution refrains from trying to offer a conceptualization and operationalization of model quality that fits every possible situation. In contrast to that, we argue that using a discourse-oriented approach can support the *identification* and the use of adequate model quality criteria fitting particular situations. Moreover, the analysis of model quality discourses according to our approach fosters the identification and investigation of a larger amount of potentially relevant quality dimensions based on systematic review of quality perspectives in the discourse and can, thus, significantly support cumulative research. Therefore, we present a procedure model and a proof-ofconcept software prototype for the practical application of the mentioned ideas of bottom-up developing a specific and shared model quality understanding in research and practice.

# 4 Discourse-Orientation in Conceptual Model Quality Research

### 4.1 Discourse-Orientation and Conceptual Model Quality

We argued above that conceptual models strongly depend on language and subjective notions. Thus, the different notions of a model's quality and the different underlying notions of *what makes a model a high-quality model* have to be identified, collected and analysed in order to get a comprehensive overview of relevant notions regarding conceptual model quality of a certain perspective. In order to do so, we propose a discourse-oriented approach for the determination of conceptual model quality. Our approach serves for the (re)construction and evaluation of model quality discourses, which fosters identifying adequate model quality criteria fitting particular situations and identifying relevant quality dimensions.

But, what actually is a *discourse* in this context? The term discourse generally describes speech acts comprising different perspectives on and beliefs about a subject matter. Often, they also show characteristics of an argument. Besides this, the term *discourse* has specific meanings within philosophy, linguistics and other scientific disciplines (Blommaert, 2005; Harris & Mattick, 1988; Potter & Wetherell, 2011). In IS research and especially in the context of conceptual modeling research, the term *discourse* has been used expressing different meanings. For instance, Ågerfalk and Erikson (2004), Halpin (2007, p. 26) as well as Sindre and Opdahl (2007) use the term *universe of discourse* for the denotation of a modeled part of reality which is up for discussion. Although the term *discourse* has sometimes been used in contributions on conceptual modeling, no explicit discussion regarding the term's meaning exists. In fact, it has been often used as a non-explicated term. Particular work using the ideas of discourse analysis has been presented by IS researchers (Auramäki, Hirschheim, & Lyytinen, 1991a, 1991b; Cimiano, Reyle, & Sanic, 2005; Ulrich, 2001a, 2001b). However, they hardly refer to conceptual model quality discourses.

Model quality discourses can be understood as combinations of communication and modeling activities according to the *language/action perspective* (Hoppenbrouwers, Proper, & Weide, 2005; Winograd, 1987-1988). The critical (re)construction and evaluation of model quality discourses offers significant advantages for model quality research. Moreover, such an approach is actually necessary to satisfy the concept of

quality which is always connected to the views and perspectives of different roles and situations. Against this background, we refrain from conceptualizing model quality a priori and follow this assumption (Fettke, Houy, et al., 2012):

The term "model quality" can be interpreted, conceptualized and operationalized very differently. Its interpretation, conceptualization and operationalization should be understood depending on a modeling discourse. A modeling discourse can be described as a combination of different communication and modeling activities in the context of the construction and application of conceptual models. Model quality indicates to what extent the model fulfils criteria whose (a) definition, (b) type, (c) extent, (d) identification, (e) value specification, (f) weighting and (g) aggregation are negotiated in a discourse between modelers, model users and evaluators. A quality discourse is the particular part of the modeling discourse that broaches the issue of conceptual model quality.

According to this definition, several description parameters for model quality criteria exist which should be considered for the negotiation of criteria in a quality discourse. These are described in more detail in the following: first of all, it is important that criteria for model quality be explained and defined in detail ((a) *definition*). Concerning the measurement of quality, different (b) *types* of criteria can be distinguished e. g., metrical or non-metrical quality criteria. The variable (c) *extent* specifies the amount of relevant model quality characteristics in a discourse. (d) *Identification* summarizes techniques which are applicable for the determination of a quality criterion. Furthermore, possible measurement values of model quality in the context of empirical investigations should also be established ((e) *value specification*). In order to allow different perspectives to use the same quality criteria in different ways, their (f) *weighting* has to be determined and plays an accordingly important role. In addition, it seems necessary to determine how several criteria can be merged ((g) *aggregation*). In the following section, our procedure model for the (re)construction and evaluation of model quality discourses is introduced.

### 4.2 A Procedure Model for the (Re)construction and Evaluation of Quality Discourses

The following procedure model proposes recommendations for how to (re)construct and evaluate conceptual model quality discourses in order to identify and understand relevant model quality criteria expressed in a discourse. These quality criteria can then be used as a basis for an adequate evaluation of conceptual models in a certain context or situation and, furthermore, serve for cumulative model quality research. Taking the specific drawbacks of top-down model quality frameworks and approaches (Krogstie et al., 2006; Lindland et al., 1994) into account, we have developed a procedure model which is supposed to support the *bottom-up* development of a dedicated model quality notion and understanding from different views and perspectives expressed by different participants in a discourse. As our procedure model is supposed to facilitate a systematic bottom-up development of quality notions it is to a certain extent geared to common methods for systematic reviews (Cooper & Hedges, 1994) which typically aim at systematically identifying, obtaining and analysing underlying sources and then at systematically presenting the results. However, our approach is, furthermore, aligned to the specific needs of model quality research which will be explained in more detail in the following step descriptions concerning our procedure model. It should be noted, that these procedure steps may vary in detail depending on the purpose of usage, viz. (I) the initial construction of a discourse or (II) the reconstruction of an existing discourse. Figure 3 gives an overview of the different steps according to (Fettke, Houy, et al., 2012). More detailed explanations follow in the consequent paragraphs.

Procedure model for the (re)construction and evaluation of conceptual model quality discourses				
Step 1: Identification and selection of the model quality discourse				
Step 2: (Re)construction of the model quality discourse				
a.Model quality definition				
b. Model quality conceptualization				
c.Model quality operationalization/measurement				
Step 3: Validation of (re)construction				
Step 4: Analysis and evaluation of the model quality discourse				
Step 5: Overall assessment				

#### Fig. 3: Procedure model, according to (Fettke, Houy, et al., 2012)

**Step 1**: Concerning the *identification and selection of the model quality discourse*, characteristic criteria and key concepts of a quality discourse topic need to be known. Based on these criteria and key concepts a discourse can be identified and delineated. To identify a model quality discourse, the following steps can be applied depending on the purpose of usage:

(I) If a conceptual model quality discourse is *initially constructed*, discourse participants have to identify the models or model parts to be discussed. Examples concerning the application of our procedure model used for the construction of a model quality dis-

course are given and illustrated during the demonstration of our proof-of-concept prototype.

(II) While applying our procedure model for the *reconstruction* of an existing scientific model quality discourse, all relevant written contributions, e. g. articles, reviewers' comments, response articles, have to be identified and analysed (*systematic literature review*). Based on these written contributions the underlying model quality understanding and the central positions in a discourse become apparent. Furthermore, relevant discourse participants can be identified. An exemplary application of our procedure model for reconstructing one part of the scientific quality discourse on model understandability is presented in the next section.

**Step 2**: In the next step, the (*re*)construction of the model quality discourse is performed. In this context, several different aspects are relevant. For the (I) *initial* construction of a discourse the participants have to define their basic notion of model quality and relevant model quality criteria according to their own perspective as a starting point. Thereafter, arguments and facts supporting their perspectives and notions are collected and documented. For the (II) reconstruction of existing quality discourses, different quality notions documented in the written discourse are identified and it is investigated how they differ. Addressed quality dimensions are explored and their conceptualization and operationalization are captured in detail. These central aspects should then be further structured. Building up a reference framework classifying the investigated quality notions should be the goal of this step. In order to support the further analysis of the discourse it seems reasonable to document additional information such as background knowledge, design recommendations etc.

**Step 3**: The quality of discourse (re)construction itself should be evaluated based on adequate criteria. This is done during the *validation of (re)construction*. In this step further information about the discourse (re)construction, such as the quality and clarity of presented results in the underlying sources, is documented and analysed. Especially the discourse reconstruction should be performed by different researchers in a research group so that potential inconsistencies or ambiguities can be eliminated and that a consistent "discourse reconstruction perspective" can be developed.

**Step 4**: The next step is the *analysis and evaluation of the model quality discourse*. In this, the content of the discourse is investigated. Different notions or understandings of model quality as well as the different occurring views and perspectives are reviewed

and compared. Furthermore, if available, similar views and perspectives as well as interesting patterns in the discourses are identified and documented.

**Step 5**: The evaluation of model quality discourses close with the *overall assessment*. In this step, a quality assessment of the discourse evaluation itself should be performed. It seems interesting to understand a discussion about the quality of several discourse evaluations as a discourse itself (*meta-discourse*). The goal of such a meta-discourse is to investigate central quality criteria for discourse (re)constructions and evaluations and to compare results on an overall level. In order to be able to start a meta-discourse, it is necessary to have different participants who discuss their discourse evaluations. Preferably, different groups of researchers perform their own, independent evaluations of a model quality discourse according to the steps 1 to 4 of this procedure model. Results can then be compared and the different evaluations can be discussed in order to get a more distinct overall understanding of the investigated model quality topic.

In the following, the potential and feasibility of our introduced procedure model is demonstrated by means of the procedure model's application. At first, we present a *reconstruction* and evaluation of a scientific model quality discourse concerning the topic *model understandability*. In this context, we do not have the claim to reconstruct the complete scientific discourse on model understandability. Therefore, a selection of empirical research contributions on this topic is taken as a basis for the demonstration of the potential of our approach.

# 5 Reconstruction and Evaluation of the Model Understandability Discourse

In the following, our procedure model is exemplarily applied for a discourse reconstruction concerning conceptual model understandability. The detailed course of action according to our procedure model and the results of each step are presented. As already mentioned, we do not have the claim to reconstruct the discourse on model understandability based on every existing publication but on a satisfying amount of literature.

### Step 1: Identification and selection of the model quality discourse

During this application, the quality discourse on model understandability is reconstructed under consideration of a certain amount of empirical research contributions. This allows reconstructing the underlying notion of model understandability. For the identification and determination of the examined discourse, a systematic review (Cooper & Hedges, 1994) of research articles in journals as well as in conference proceedings containing results on model understandability was performed. In order to identify relevant contributions, the following search terms were used for forward search in three literature databases (*Science Citation Index, Scopus* and *EBSCO Business Source Premier*): "understand\*", "comprehen\*", and "conceptual model\*", "process model\*", "data model\*". Moreover, further contributions have been identified by means of a backward search and any additional relevant literature known to the authors which was not retrieved by the above described search has also been added to this population of articles. In total, 49 contributions, mostly experiments published in journals and conference proceedings, have been identified serving as a basis for our exemplary discourse reconstruction and evaluation. Although it seemed to be reasonable to only consider the journal publications for our reconstruction as "finalized pieces of research", we decided to investigate both types of contributions as in some cases different aspects of model understandability are stressed and interesting insights could be drawn from doing so.

#### Step 2: Reconstruction of the model quality discourse

Firstly, every article's research design was investigated. In this context, all used variables, their operationalization as well as the measurement instruments concerning the dependent variable ("understandability") and other interesting meta-information were analysed and documented. Table 1 on the next page presents an excerpt with two examples taken from the overview of documented research designs, variables and measurement instruments used. In this context, the column named N contains the number of participants in an empirical study (mostly experiments) or its replications.

Our investigation shows that *model understandability* has been conceptualized and measured quite differently within the 49 contributions. While Agarwal et al. (1999) consider only one dimension of understandability, which they measure by means of comprehension questions, Bodart et al. (2001) define different "depths of understanding". *Surface-level understanding* corresponds to correctly recalling model parts while a *deeper-level understanding* is related to correctly answering questions concerning the model content, which is relevant for problem solving. Furthermore, it seems interesting that a plethora of different measurement instruments for model understandability have been used. While, e. g., in the contribution of Agarwal et al. (1999) the answers concerning the comprehension test were documented and their correctness was subjectively assessed by the conductor of the experiment (*expert judgement*) using a 7-point Likert scale, in Bodart et al. (2001) the number of correctly recalled model parts or successfully solved problems was counted. Hence, it can be stated that not only has model understandability been defined quite differently, but its measurement also significantly varies in empirical research contributions.

Reference Research design		N	Independent variables	Dependent variables	Measurement instrument for understandability
Agarwal et al. (1999)	Laboratory experiment + replica- tion, two groups, participants randomly assigned	36 + 35	Modeling approach:1. Usage of object- oriented models (structure)2. Usage of process- oriented models (behaviour)	Understandability: 1. Accuracy of model comprehen- sion	1. Comprehension test: comprehension score rating participants' answers (7-point-Likert scale) on eight comprehension questions.
Bodart et al. (2001)	Three laboratory experiments, mixed designs, randomly assigned participants	52 + 52 + 96	Representational complexity: 1. Mandatory properties representation 2. Optional properties representation	Understandability: 1. surface-level understanding 2. deeper-level understanding (response accura- cy and problem- solving)	<ol> <li>Seven measures for recall accuracy: total number of correctly recalled construct instances (entities, relationships, attributes, attributes recalled and typed correctly, relationships recalled with correct cardinalities etc.)</li> <li>Response accuracy: 10 comprehension questions, response time (in seconds), normalized accuracy (accuracy score divided by time score) and three measures for problem-solving performance concerning 9 questions (the number of correct answers based upon information in the conceptual model; (b) the number of correct answers provided by a participant based upon extra-model knowledge; and (c) the number of incorrect answers provided by the participant.)</li> </ol>

Tab. 1: Excerpt of reconstruction results, according to (Houy et al., 2012)

The different conceptualizations of model understandability which were found during the reconstruction of the quality discourse have been classified into categories differentiating objectively measurable vs. subjective as well as effectiveness- vs. efficiencyrelated dimensions. These dimensions have been used as the main categories for the overview of understandability dimensions in table 2.

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	Investigated model types		Subjective dimension					
		effectiveness				efficiency	effectiveness	
References		1. Recalling model content	2. Correctly answering questions about model content	3. Problem- solving based on the model content	4. Verifica- tion of model content / dis- crepancy checking	5. Time need- ed to under- stand a model	6. Perceived ease of under- standing a model	
1. Juhn and Naumann (1985)	data		•	•				
2. Palvia et al. (1992)	data		•			•	•	
3. Shoval and Fruerman (1994)	data		•					
4. Hardgrave and Dalal (1995)	data		•			•	•	
5. Kim and March (1995)	data		•		•			
6. Shanks (1997)	data						•	
7. Agarwal et al. (1999)	data / process		•					
8. Burton-Jones and Weber	data			•			•	
9. Nordbotten and Crosby (1999)	data		•					
10. Bodart et al. (2001)	data	•	•	•				
11. Moody (2002a)	data		•		•	•		
12. Purchase et al. (2002)	process				•	•	•	
13. Parsons (2003)	data		•			•		
14. Moody (2004)	data		•		•	•		
15. Serrano et al. (2004)	data		•			•		
16. Gemino and Wand (2005)	data		•	•		•	•	
17. Poels et al. (2005)	data		•					
18. Sarshar and Loos (2005)	process		•				•	
19. Burton-Jones and Meso	data		•	•			•	
20. Khatri et al. (2006)	data		•	•				
21. Cruz-Lemus et al. (2007)	process	•	•	٠				
22. Mendling et al. (2007)	process		•				•	
23. Recker and Dreiling (2007)	process		•	•		•	•	
24. Serrano et al. (2007)	data		•			•		
25. Burton-Jones and Meso	data		•	•			•	
26. De Lucia et al. (2008)	data		•					
27. Genero et al. (2008)	data		•			•	•	
28. Mendling and Strembeck	process		•					
29. Patig (2008)	data		•			٠		
30. Shanks et al. (2008)	data			•		•	•	
31. Reijers and Mendling (2008)	process		•					
32. Vanderfeesten et al. (2008)	process		•					
33. Cruz-Lemus et al. (2010)	process		•			•		
34. Fuller et al. (2010)	data		•					
35. Mendling et al. (2010)	process						•*	
36. Sánchez-González et al.	process		•			•		
37. Shanks et al. (2010)	data		•	•	•	•		
38. Bavota et al. (2011)	data		•					
39. Figl and Laue (2011)	process		•				•	
40. Ottensooser et al. (2011)	process		•	•				
41. Parsons (2011)	data		•				•	
42. Recker and Dreiling (2011)	process		•	•		•	•	
43. Reijers and Mendling (2011)	process		•					
44. Reijers et al (2011)	process		•					
45. Sánchez-González et al.	process		•			•		
46. Schalles et al. (2011)	data / process	•	•			•		
47. Allen and March (2012)	data		•					
48. Mendling et al. (2012)	process		•			•		
49. Milton et al. (2012)	data				•			
•: understandability dimension has	been observed	in this contri	bution					
*: in this contribution "perceived ambiguity of a label" and "perceived usefulness of a label for understanding a model" were								
measured. We consider these two categories to be closely related with "perceived ease of understanding a model".								

Tab. 2: Dimensions of understandability, sources in chronological order,extended overview based on (Houy et al., 2012)

#### Step 3: Validation of reconstruction

The discourse on model understandability in our example could be reconstructed very precisely. This was mainly enabled by the circumstance that all participants of the quality discourse concerning model understandability had done a good job to meet the general quality requirements of empirical research contributions. The fact that many of the investigated contributions were published in highly-ranked publication outlets with high quality standards – such as ISR, JAIS or MISQ – resulted in a reconstruction without larger difficulties. Thus, the high quality of underlying contributions and the full accessibility of construct conceptualizations and operationalization provided good preconditions for a valuable discourse reconstruction. If any uncertainties or different opinions among the authors of this article occurred during the reconstruction, e. g., while classifying articles according to the categories used in table 2, these points were discussed and resolved.

#### Step 4: Analysis and evaluation of the model quality discourse

The exemplary reconstruction of the model understandability discourse shows that model understandability has been quite differently defined and interpreted, conceptualized and measured. This allows for the first central finding: research results on conceptual model understandability can be ambiguous and are, thus, only conditionally comparable. Understandability as an important dimension of model quality and the act of understanding a model are described by several different characteristics and dimensions in the investigated articles, e. g., by *correctly recalling model content, problem solving based on models* or *quickly answering questions about the model content*. As shown in table 2, model understandability was refined into subjective and objective as well as effectiveness- and efficiency-related dimensions. In this context, *correctly answering questions about the model content* is a major dimension which was used in 43 of the 49 investigated experiments. Likewise, *problem-solving based on the model content, perceived ease of understanding a model* or *time needed to understand a model* are considered important dimensions while the other two seem to play a rather small role.

However, in every case research results concerning model understandability are presented, which can make these results ambiguous if the underlying conceptualization of understandability is not explicitly considered. If, e. g., two experiments compare the understandability of *UML class diagrams* and *entity relationship models* and one of them investigates *perceived ease of understanding* while the other analyses *time needed* 

*to understand a model* and both come to the conclusion that UML class diagrams are easier to understand, these final statements are actually hardly comparable and rather complement each other instead (Houy et al., 2012). In order to further clarify the dimensions of model understandability and to support the communication between researchers about the topic, the discourse reconstruction results (table 2) can serve as a reference for future definitions of variables in empirical research.

Another interesting observation and a second finding of our analysis is the following: In general, interesting and well-organized empirical work on model understandability has been conducted in recent years. However, a common notion and conceptualization of model *understandability* has evolved only to a certain extent. It could be intuitively expected that in several years of research on model understandability a more consensual and common notion of model understandability could have evolved than it can be observed from the data. These observations have several implications which are discussed in the overall assessment of the discourse.

#### Step 5: Overall assessment

During this application of the procedure model, the authors take the perspective of one individual participant in the modeling meta-discourse. Thus, the overall assessment of the discourse is limited to the discourse reconstruction and evaluation performed in this article. Our investigation of empirical contributions revealed interesting differences concerning the notion and measurement of model understandability. Our article's general assumption regarding the conceptualization of model quality fully applies to model understandability. The results of our evaluation corroborate the assumption that for a deeper understanding of model quality criteria it is helpful and necessary to consider as many different perspectives as possible. While the discourse reconstruction in table 2 gives an insightful overview of different conceptualizations of model understandability, it seems quite notable that within several years of valuable research no consensus concerning the conceptualization of model understandability has been established. However, to accomplish a consensus towards a common notion of model understandability would be of high interest from the point of view of cumulative research. A further interesting point lies in the fact that many research results are only conditionally comparable as they have different basic notions of understandability. However, the results of this exemplary discourse reconstruction and evaluation strengthen the assumption that discourse-orientation can significantly support the development of a better understanding of conceptual model quality. In the next section, we present a software

prototype which has been developed as a proof-of-concept supporting the introduced procedure model. It offers interesting potential also for model quality improvement in practice, as will be shown in the following.

# 6 Proof-of-Concept Prototype for the (Re)construction of Model Quality Discourses

### 6.1 Presentation of the Prototype

The proof-of-concept software prototype introduced in the following supports the (re)construction and evaluation of conceptual model quality discourses according to our procedure model. It facilitates the documentation and transparent presentation of different positions concerning central model quality aspects in a discourse, which is not only interesting for discourses held in scientific communities. This can also be a valuable tool for modeling discourses in enterprises and other organizations, which has to be regarded a demanding endeavour. It is one of the main goals of our prototype to support a better accessibility and more distinct collective understanding of model quality. This shall be realized by means of the common characteristics and advantages of computer-supported cooperative work (CSCW) systems, like the bridging of time and space. Furthermore, IT-supported discourse development in organizations by means of our prototype can help to improve the understanding of the usage of terms in conceptual models and the requirements towards a model in different organizations.

Our prototype has been implemented in Java and supports all phases of the procedure model. In the current version, users can upload process models, e. g. in EPML as well as in other graphical formats like JPEG, TIFF etc. The prototype supports the different steps of our procedure model which will in the following be illustrated by means of certain steps in the context of the initial construction of a model quality discourse in practice:

### Step 1: Identification and selection of the model quality discourse

In the first step, the participants identify the discourse topic, the model or model part to be discussed and all the relevant stakeholders of the following model quality discourse (see figure 5.A on the next page). To support this, the following questions guide the identification of relevant information by means of the prototype:

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- 1. *Model:* Which model should be analysed?
- 2. *Graphical representation:* Which representation should be used to evaluate the model?
- 3. *Discourse participants:* Who should participate in the discourse?

#### Step 2: Construction of the model quality discourse

In the second step, the stakeholders have to define which quality criteria should be discussed in the discourse and how they should be weighted during the evaluation. Moreover, an exact definition of each model quality criterion has to be specified by every stakeholder discussing this criterion. Thus, the different notions of quality criteria become transparent for the discourse participants. In order to structure the necessary data for the negotiation of the model quality criteria, we use the argumentation model presented in figure 4 for the implementation of our prototype.



Fig. 4: Argumentation model implemented in the prototype

According to this argumentation model, every model quality discourse has a root discourse object as a basis (*discourse level*), viz. the conceptual model or model part to be discussed. On the *criteria level*, all relevant criteria for the determination of a conceptual model's quality are listed, e. g. as "semantic correctness". As already mentioned above, all criteria have to be defined before a model quality discourse can be started. The different criteria are summarized based on a definable logic. Discussions and decisions, e. g. *how well* certain criteria are fulfilled by a given conceptual model, are based on the discourse participants' postings (*post level*). Every post contains argumen-

tation judging to what extent a criterion is fulfilled from a participant's point of view. An argumentation consists of at least one or several detailed arguments which are presented on the *argument level*. Arguments are typically supported by facts which represent the lowest discourse level in our argumentation model (*fact level*). In order to be able to construct and evaluate model quality discourses, a clear definition and a set of rules are needed concerning *how* arguments are summarized into posts and *how* posts affect criteria and, finally, the model quality. Rules can be developed by discourse participants assisted by the prototype (figure 5.A). For the elaboration of the initial discourse parameters, the following questions are supposed to help in preparing the argumentation process:

1. Discourse criteria: Which criteria should be used for evaluation?

- 2. Criteria definition: How should the criteria be defined?
- 3. Criteria weighting: How should the criteria be weighted to evaluate the model?

4. Discourse aggregation: How should the elements on specific discourse levels be aggregated?



Fig. 5: Screenshots of different functional areas of the prototype

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Then, the argumentation within the model quality discourse is constructed. Based on the defined discourse parameters and on the argumentation model, the participants can post their statements concerning the model's quality related to the different defined quality criteria. The prototype also supports adding annotations to certain parts of a model. The different posts are supposed to be supported by valid arguments which, themselves, should be supported by convincing facts. An exemplary argumentation structure is given in figure 5.B. The different levels of the argumentation model (*criteria, post, arguments* and *facts*) are represented by different tabs in the prototype. The argumentation as a central part of the discourse is visualized by means of a tree structure in figure 5.B. The aggregation process and the presentation assessment functionalities. In the presented by different automatic argumentation assessment functionalities. In the criterion *semantic correctness*. Three posts with different arguments concerning semantic correctness exist in this argumentation. The argument structure shown on the right hand side in figure 5.B corresponds to the first post regarding this quality criterion.

#### Step 3: Validation of construction

Thereafter, the discourse participants can evaluate and discuss the discourse contributions based on the facts, arguments, posts and criteria all the stakeholders have provided and which have been documented by means of the prototype. Thus, the different discourse positions can be validated and the validated argumentation (*Rate post, figure* 5.C) provides the basis for the later analysis, and evaluation of the constructed model quality discourse.

#### Step 4: Analysis and evaluation of the model quality discourse

The evaluation process is supported by the rules of aggregation defined at the beginning. Thus, evaluation results are based on the same assumptions, facts and the collaboratively defined structures. Based on the validated posts and arguments as well as on the general survey of documented discourse parameters, the model quality discourse can be collaboratively evaluated and decided (*Decide post, figure 5.C*). It can be assumed that such a discourse-oriented quality evaluation significantly contributes to a better understanding of all relevant requirements of model users or stakeholders within a modeling community or an enterprise and, consequently, to a better model quality.

#### Step 5: Overall assessment

The prototype, furthermore, allows for the comparison of different documented quality discourses and, thus, supports an overall assessment of discourses on the same model or the same model parts. This step is most likely more relevant for scientific investigations. However, if e. g. several discourses on the same reference process model were constructed in different organizations, the comparison of these discourses could be of considerable help when investigating the quality of reference process models from the perspective of different organizations. Such results could be of major importance for research and for practice.

# 6.2 Exemplary application and assessment of the proof-of-concept prototype

In order to investigate the usefulness and general feasibility of our prototype, an assessment of the prototype has been conducted by means of an exemplary application. It is commonly known that a broad empirical evaluation of design artefacts is no trivial endeavour and researchers designing new IS artefacts only seldom have the possibility to perform field test or laboratory experiments with a "satisfying amount" of participants to be able to make universally valid statements about the effects and side-effects of their design object (Vanderhaeghen, Fettke, & Loos, 2010). As we present a first assessment of our prototype in this research we do not either have the claim to present universal results. In contrast, this assessment serves as a first investigation of the general feasibility which is supposed to support the further development of the prototype instead of claiming to have a finished prototype which is now ready for comprehensive quantitative assessment. For our assessment, a real-life EPC model representing the process of the application for parents' money in a German public authority (partly presented at the top of figure 5.A) has been taken as a basis and evaluated by three groups of users. Parent's money (German: Elterngeld) is a payment which is supposed to encourage couples to become parents. It is financed by means of taxes and is supposed to support the costs for bringing up a child. Each of the three user groups consisted of three master students with different process modeling experience (I. experts, II. laymen, III. *mixed group* with two laymen and one expert – this was done in order to see which influence the expertise of one person in the group had in a prototype-supported evaluation in comparison to a non-prototype-supported evaluation). Each person in a group investigated and evaluated the model from the point of view of a different organizational unit involved in the process represented in the model. For evaluation purposes,

the original model has been slightly modified in such a way that several syntactic and semantic ambiguities and even mistakes were included. All the three groups independently performed their model quality evaluation. After short introductions to discourse-oriented model quality evaluation, business process modeling with EPCs and the parents' money application process by means of a textual description, the model was at first evaluated in each group without the prototype, then using the prototype. In this context, we checked whether more mistakes and critical parts were identified with or without using the prototype and counted the number of identified critical parts. After finishing the evaluation, an interview with every single participant was conducted in order to find out about their perceptions of working with the prototype.

It showed that a discourse-oriented quality evaluation has in general been perceived to be a complex task. The task complexity is mostly thought to originate from the complicated choice of adequate quality evaluation criteria, the model analysis per se as well as the determination of the influence of different model parts on overall quality. Unsurprisingly, it showed that this task has been perceived to be easier for test persons with a longer modeling experience. In total, the prototype was found to support a more transparent and traceable finding and appointment of relevant quality criteria which could later on support the generation of more comparable evaluation results comprising many relevant views on a business process model. Furthermore, the whole process of getting there can also be documented which was perceived to be very useful to understand the evaluation process afterwards. In total, the results provided by the evaluation with the prototype were found more useful in comparison to the "manual" evaluation.

When using the prototype a higher amount of critical model parts were identified as far as syntactic and semantic ambiguities and mistakes were concerned. This was not only the case for the expert group but also for the mixed group in which the expert shared his valuable knowledge in the discourse with the two laymen. These positive effects can mainly be explained based on the documented discussion of model parts and the transparent compilation of opinions about the model from different perspectives. This supports a better accessible and more distinct collective understanding of model quality. Nevertheless, as mentioned above it was our goal to present a *first assessment* of our prototype and we did not have the claim to present universal results. The main contribution of this section is rather to demonstrate the general feasibility of our prototype and, thus the general potential of our discourse-oriented approach.

### 7 Discussion

Based on the assumptions that the notions of model quality and adequate quality criteria differ and that a multi-perspective view is helpful and even necessary while trying to understand model quality including all the different perspectives, we have presented a procedure model for the (re)construction and evaluation of conceptual model quality discourses. With the exemplary applications of the procedure model and the prototype, we have demonstrated the potential of discourse-orientation for conceptual model quality ty research and model quality improvement in practical organizations.

The exemplary application of our procedure model regarding the reconstruction of the scientific discourse on conceptual model understandability showed that understandability as an important model quality criterion is indeed conceptualized and operationalized very differently. Established top-down model quality frameworks such as the semiotic model quality framework or SEQUAL do not provide differences in model quality notions and understandings in such a detailed manner. Thus, they do not provide the same specific results as our study using a discourse-oriented approach. Our approach has fostered the identification and detailed documentation of the different notions in this particular discourse. Especially for the sake of successful cumulative research on model understandability, it would be very interesting to further the development of a more consensual view on the conceptualization of model understandability. Such an endeavour would strengthen the comparability of research results. Moreover, this would improve the fundament of empirical results of our community which are used to test and develop the theoretical foundations of our research discipline. The presented discourse reconstruction results and especially the overview of dimensions of model understandability could serve as a starting point towards such an initiative and help to improve communication between researchers investigating model understandability. Broadly supported patterns in empirical results indicating which particular factors have proven to improve model understandability, such as model decomposition or the usage of certain modeling techniques, can also serve for the improvement of conceptual model quality in practice (Houy, Fettke, & Loos, 2011). Our procedure model has shown to be a useful guide for the process of identifying and extracting interesting information about the scientific discourse on model understandability. However, further research into the usage and application of the procedure model is necessary, especially under consideration of a broader variety of discourse contributions such as reviewers' comments on articles or response articles.

Our procedure model and the proof-of-concept software prototype can also be relevant for practice. IT-supported discourse development in organizations can help to improve the understanding of the usage of terms in conceptual models and the requirements towards a model in different organizational units. Thus, IT-supported discourses can improve communication in organizations. This is an important point because a lack of clarity in language and ambiguous model quality criteria may have crucial influence on organizational success. Considering the different perspectives for model quality evaluation and a corresponding systematic advancement of models may significantly improve modeling success in practice. However, as a matter of fact it should be stated that a nonconsistent use of language in organizations is not totally unusual and organizations may anyway be successful. Nevertheless, it can be expected that using our approach can improve the design of conceptual models in practice by delivering an overview of relevant quality dimensions from different stakeholder perspectives.

Our research, however, also has some *limitations*. So far, we have presented conceptual argumentation on the potential and relevance of discourse-orientation as well as a procedure model and a proof-of-concept prototype. The exemplary application of our approach in a research context (*model understandability research*) as well as the presentation and investigation on the proof-of-concept prototype confirmed our argumentation on the potential of our approach to some extent. However, further empirical research and more detailed evaluation of the effects of using discourse-oriented approaches in model quality research are needed both in research and practice. We are aware of the fact that business organizations in practice will only consider using a rather time-intensive approach for model improvement if a significantly positive effect can be expected. In this context, we plan more comprehensive evaluation activities together with our project partners from practice in the future.

# 8 Conclusion and Outlook

Based on the assumptions that the notions of model quality and adequate quality criteria differ and that a multi-perspective view is helpful and even necessary while trying to understand model quality including all the different perspectives, we have introduced a procedure model for the (re)construction and evaluation of conceptual model quality discourses. With the exemplary applications of the procedure model and the prototype, we have demonstrated the potential of discourse-orientation for conceptual model quality research and practice.

In general, discourse-oriented model evaluation and the documentation of different notions and understandings of model quality are necessary to make scientific results and practical requirements unambiguous and clear. A comprehensive understanding of these different notions and a precise documentation of empirical research results are crucial for cumulative research in conceptual modeling and for the development of dedicated theories. Against this background, a consistent and precise use of terminology of IS research in general, and of conceptual modeling in particular is of major importance. In this regard, our approach can also make a contribution to further sharpen and clarify terminological issues by means of discourse analyses.

In conclusion, discourse-orientation in the context of model quality research can contribute to the identification and understanding of relevant model quality criteria in general and, as a consequence, to the development of valuable conceptual models. Against this background, it seems important and promising for future IS research to not only advance evaluation methods for models but also to gain a deeper insight into the relevant dimensions of conceptual model quality by means of discourse-oriented approaches.

We are currently planning to develop our first prototype towards an easier usage. The prototype should be straightforward usable by different participants in a model quality discourse independently of their modeling experience and IT affinity. Especially in this field we are planning more comprehensive evaluation activities together with our project partners from practice in the future. Furthermore, deeper investigations into the effects of using discourse-oriented evaluation in organizations are planned also using quantitative methods.

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Unter der wissenschaftlichen Leitung von Professor Dr. Peter Loos sind am Institut für Wirtschaftsinformatik (IWi) im Deutschen Forschungszentrum für Künstliche Intelligenz (DFKI) mehr als 60 Mitarbeiter im Bereich der anwendungsnahen Forschung beschäftigt. Seit das Institut vor 30 Jahren durch Prof. Dr. Dr. h.c. mult. August-Wilhelm Scheer gegründet wurde, wird hier in Forschung und Lehre das Informations- und Prozessmanagement in Industrie, Dienstleistung und Verwaltung vorangetrieben. Ein besonderer Anspruch liegt dabei auf dem Technologietransfer von der Wissenschaft in die Praxis.

Die interdisziplinäre Struktur der Mitarbeiter und Forschungsprojekte fördert zusätzlich den Austausch von Spezialwissen aus unterschiedlichen Fachbereichen. Die Zusammenarbeit mit kleinen und mittelständischen Unternehmen (KMU) hat einen bedeutenden Einfluss auf die angewandte Forschungsarbeit – wie auch Projekte im Bildungsund Wissensmanagement eine wichtige Rolle spielen. So werden in virtuellen Lernwelten traditionelle Lehrformen revolutioniert. Das Institut für Wirtschaftsinformatik berücksichtigt den steigenden Anteil an Dienstleistungen in der Wirtschaft durch die Unterstützung servicespezifischer Geschäftsprozesse mit innovativen Informationstechnologien und fortschrittlichen Organisationskonzepten. Zentrale Themen sind Service Engineering, Referenzmodelle für die öffentliche Verwaltung sowie die Vernetzung von Industrie, Dienstleistung und Verwaltung.

Am Standort im DFKI auf dem Campus der Universität des Saarlandes werden neben den Lehrtätigkeiten im Fach Wirtschaftsinformatik die Erforschung zukünftiger Bildungsformen durch neue Technologien wie Internet und Virtual Reality vorangetrieben. Hier führt das Institut Kooperationsprojekte mit nationalen und internationalen Partnern durch: Lernen und Lehren werden neu gestaltet; Medienkompetenz und lebenslanges Lernen werden Realität. Zudem beschäftigen sich die Mitarbeiterinnen und Mitarbeiter mit dem Einsatz moderner Informationstechniken in der Industrie. In Kooperation mit industrieorientierten Lehrstühlen der technischen Fakultäten saarländischer Hochschulen werden Forschungsprojekte durchgeführt. Hauptaufgabengebiete sind die Modellierung und Simulation industrieller Geschäftsprozesse, Workflow- und Groupware-Systeme sowie Konzepte für die virtuelle Fabrik.

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