Tool Support for the Collaborative Design of Reference Models – A Business Engineering Perspective

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Abstract

The central idea in reference modeling is the reutilization of the business knowledge contained in reference models for the construction of specific information models. The orientation on the technical content of a reference model can increase the efficiency of processes in business engineering projects. Despite this, the use of reference models in the field of business engineering has not established itself in practice. This is due to the particular field of conflict between research and practice, in which reference modeling is at home. Thus, there is still a deficit in knowledge about the use and problems inherent in the implementation of reference models despite the array of theoretical concepts. Accordingly, in the past years the supply-sided development of reference models predominant in the science world has distanced itself from their demand-sided use in business and administration. The article at hand analyses this problem and presents an integrative approach to the computer-aided management of reference models. The task to be mastered using the proposed approach will be conceptually concretized with an framework and prototypically implemented in the form of a reference model management system.

1. Reference Modeling as an Instrument of Business Engineering

1.1. From Business Engineering to Business Process Management

The field of “business engineering” emerged at the start of the 1990es as a management trend that was to enrich the approaches existing at the time with respect to the development of operational information systems with considerations on strategy and process design [7; 16; 17; 19; 20]. From today’s perspective, business engineering can be understood as the method and model-based design theory for businesses in the information age [18]. Using the methods and models made available by business engineering, businesses and strategic fields of business were to be redesigned – taking advantage of the potentials in information technology (IT) – from the bottom up with the help of engineering principles. Business processes have established themselves as the organizational objects of design for this task [9; 12]. Thus, the design of business processes and the analysis of the demands to their IT-support with regard to corporate strategy are of importance in business engineering projects. The design of business processes must follow a comprehensive approach, which encompasses the planning and control, as well as the management of the operational workflows.

1.2. From Business Process Management to Reference Modeling

Information modeling has proved to be useful in supporting the systematic procedure in process design [11; 13; 15; 26]. Modeling techniques such as, for example, the event-driven process chain (EPC) [14], serve as operationalized approaches for the construction of models. Software tools for business process modeling, such as the ARIS-Toolset, can support the business engineer by way of system components for the collection, design, analysis and simulation of business process models [1].

Due to the possibility of their being reutilized, in many cases the construction of information models is connected to the demand to abstract from enterprise-specific characteristics. One therefore distinguishes between enterprise-specific information models and reference models. While enterprise-specific models refer to a concrete enterprise context, reference models pose target recommendations for a class of businesses [23]. Prominent examples of this in the scientific field are the reference model for industrial enterprises (Y-CIM-Model) from Scheer [20], as well as the SAP R/3-reference model resulting from commercial practice [8].

The possibility of orienting oneself on the technical content of such reference models promises on the one hand, savings in time and costs to those carrying out business engineering projects and on the other hand, an increase in the quality of the model to be constructed because reference models represent general recommendations for the subject area being studied.
1.3. Reference Modeling in the Tug-of-War between Research and Practice

The use of reference models hasn’t been able to establish itself despite the potential attributed to them in literature for business engineering projects. Reference modeling, as a field of research in the information systems discipline, especially finds itself in the tug-of-war between research and practice. This field of conflict is characterized by the fact that the theoretical foundation for reference modeling propagated by the research world seldom coincides with the pragmatic simplicity of reference models and the manageability of their enterprise-specific adaptation in practice [24]. This discrepancy can basically be attributed to the following fields of difficulty:

- **Research diversity**: The number of scientific contributions on the topic of reference modeling has multiplied in the last few years. The number of modeling methods and techniques applied with the corresponding approaches is so diverse, that even their classification has become a subject of reference modeling research [10]. Up to now, few recommendations for the case-specific selection of classes of methods or individual techniques of reutilization have been made. A business engineer in the role of a reference model-user is therefore hardly in the position of deciding which of the methods and techniques suggested in literature are adequate for his use case.

- **Findings deficit**: There is a considerable degree of unanimity in literature regarding the application possibilities of reference models. Nevertheless, few empirical studies on the topic of “reference modeling” are documented. Thus, a deficit still exists regarding the benefits and problems inherent in the use of reference models [4].

- **Implementation deficit**: The deficit in findings mentioned above is also reflected in the lack of IT-implementations. Despite the diversity of the theoretical solutions for sub-problems in reference modeling, only a few of these concepts were implemented technically or tested in practice.

1.4. The Challenge: The Management of Reference Models

The current occupation with reference models focuses on a central question in business information systems: “How can application systems and organizations be designed so that they correspond with the demands of their ‘environment’ as best possible?” The analysis of this problem pertains to many interdisciplinary fields of work, such as for example, organizational theory, systems theory, enterprise modeling, business process management, knowledge management, and software engineering.

However, respective theoretical concepts often neglect the competition-relevant role of knowledge about the design of application systems and organizations. Therefore, based upon the theoretical concepts, the following modified question should also be asked regarding the problem discussed above: “How is the knowledge concerning the design of application systems and organizations planned and controlled?” Moreover, if one understands reference models as memories for explicit domain knowledge, then one must interpret reference modeling – at least for the domain of application system and organization design – as an instrument, which aims at the transfer of business and IT-knowledge and if one summarizes the terms planning and control in the term “management”, then the resulting question can be none other than: “How can reference models be ‘managed’?”

Correspondingly, the planning and control of the creation and use of reference models is understood by the term reference model management (RMM).

2. Reference Model Management

2.1. Core Functions

The management of reference models can be conceived as a process. This process is characterized by creativity and is highly complex due to its multifariousness and dependency on human judgment. Procedure models can be used in reference modeling to help make this complexity controllable. These procedure models – an overview can be found in [25] – emphasize the developmental phase of a reference model on the one hand and, on the other, the phase of creation of enterprise-specific models based on a reference model, i.e. its usage. In both cases, a process of construction must be gone through and this process can be supported by operationalizeable approaches to the creation of models. The processes of development and usage of a reference model are however usually chronologically, as well as contextually and organizationally separated from one another:

- **Chronological separation**: A model can be referred to as a reference model when used to support the construction of other information models. Thus, the construction of a reference model always precedes the construction of specific models.

- **Contextual separation**: Usually, the reference model constructor does not know the demands regarding the
content of future reference model adaptations. He must therefore, try to foresee them.

- **Organizational separation:** The model provider and customer, resp. constructor and user are usually different people, departments or companies.

This separation of the processes “reference model development” and “reference model usage” as regards time, context and organization is seen here as a problem of integration. Thus, we can identify the development, usage and integration of reference models as the core functions of reference model management [22; 24]:

- **Reference model development:** The planning and realization of reference model construction. The development of reference models encompasses the acquisition of and search for relevant information sources and content, as well as the explication and documentation of employee’s application system knowledge resp. organizational knowledge. The development of reference models refers to the development of new reference models, as well as the modification and continual improvement of existing reference models.

- **Reference model usage:** The planning and realization of the construction of information models using reference models. The usage of reference models comprises the search for and navigation of the reference models relevant for the use case, their selection and distribution to the persons concerned the presentation of knowledge content, as well as the support of the reference model adaptation. It also comprises the retroactive evaluation of the reference models used and associated information.

- **Reference model integration:** The fusion of the chronological, contextual and organizationally separated processes in the development of reference models and the use of reference models for the construction of enterprise-specific models in the sense of the (re) creation of a whole.

2.2. IT-Support

Due to the magnitude of the information models in business engineering projects, their economic construction and use can only be guaranteed with the help of IT. IT-support can considerably increase the efficiency of processes in business engineering projects. Therefore, there is no need to debate whether it makes sense to develop a computer-aided information system for the management of reference models from the research perspective, as well as from the practice perspective. This question has long been “answered” by the economic success of modeling and analysis-tool providers [21].

On the contrary, we must investigate the question of how an information system should be designed so that it can support reference model management adequately. With emphasis on the aim of business information systems – in the sense of the planning, construction and modification of operational reality and supportive information systems – the goal to be achieved cannot be found in design alone, but rather also in the realization of an information system which can support the management of reference models. This information system will be referred to as a reference model management system (RMMS).

3. Reference Model Management System

3.1. Framework

The framework shown in Figure 1 illustrates the most important components of an RMMS, as well as their functional interaction.

![Reference Model Management System – Framework](image)

On the tool layer, the core functions of the management of reference models form the main functionalities of the information system for the support of reference model management. The link between the elements “reference model development” and “reference model usage” is created by the element “reference model integration”.

The information model for reference model management, derived from the conceptual layer, can be seen as the core component for the organizational framework. It is a semantic data-model, which is used to clarify relevant terms, as well as to define a uniform terminology. The RMM-information model forms the technical basis for the functionality “reference model integration” of the RMMS on the tool layer. It is however,
The selection
The results of the modeling
Within
specificity of the underlying model object (e.
reference model must be attributed [10] and – due to the
scientific environment to which the construction of the
one-time initiatives. Thus, on the modeling layer,
professional tools could be used for the design of the
component “modeling and analysis”. The functionalities
necessary for the development and usage of reference
models which, for example, require a model modification,
have already been implemented in corresponding systems.
Functionalities which, however, serve the documentation
of a construction process or a certain procedure in the
usage of reference models in business engineering may
require a new implementation.
In addition to human judgment, the user interface of
the RMMS (interaction layer) represents a large
bottleneck in the implementation of computer-aided
information systems. Great importance must therefore be
attributed to its design.

3.2. Collaboration as Integrating Component

Plans for the development and use of reference models
have two typical characteristics: (1) They begin with the
definition of the requirements, to be made on the
(reference-) models to be constructed and end with the
release of the design results. They are thus,
chronologically terminable and have a definite beginning
and end. (2) In many aspects, these plans are a case of
one-time initiatives. This especially applies to the
scientific environment to which the construction of the
reference model must be attributed [10] and – due to the
specificity of the underlying model object (e. g. enterprise
or application system) – for plans for using reference
models. As a result of these characteristics processes for
the development and use of reference models have, as a
rule, project character.
Projects are often very difficult for organizations
because they are not structured with regard to the
execution of these chronologically terminable and unique
plans, but rather with regard to the execution of routine
tasks. The execution of projects therefore requires an
accompanying project management which supports the
planning and control of the individual activities, as well as
the use of resources. Because this argument also applies
to the projects considered in this paper for the
development and use of reference models, the transfer of
the respective insights from the field of project
management appears profitable.
Projects serving the development or usage of reference
models are of special interest here. They are referred to as
reference modeling projects. Examples of reference
modeling projects are process-oriented reorganization
projects in which reference process models are used or the
reference model-based implementation of an ERP-system
[2].
Reference modeling projects display other
characteristics – in addition to those already mentioned
(chronological limitation and singularity) – which are
important for the conception of the RMMS-functionality
for reference model integration. These characteristics are
described below:

- **Project specific methodical framework**: The selection
  resp. specification of modeling methods and languages
  is necessary for reference model development projects
  [3]. The methodical instruments used in the framework
  of several projects can therefore vary.

- **Sub-project character**: The results of the modeling
  projects often flow into higher-level projects. Thus, for
  example, in early phases, software development
  projects often embed activities for the construction of
  information models which serve as the basis for the
  system development – which were carried out as
  separate projects. The same applies to reorganization
  projects during which the comprehensive search for as-
  is models and construction of to-be models is carried
  out.

- **Participation of several heterogeneous actors**: Within
  the framework of reference modeling projects there are
  often sub-activities which are difficult to forecast and
  which exceed the competences and responsibilities of
  individuals. The collaboration between method
  experts, with knowledge in modeling methods and
  languages and experts with knowledge pertaining to
  enterprise structures and processes is especially
  important for projects serving the creation and use of
  reference models. In addition, consulting firms or
  scientific institutions can also be called in for help in
  the development of models and the collaboration of all
  these heterogeneous actors must be coordinated.

The RMMS must therefore have functionalities which
support the collaboration between project groups and
teams spanning departments and locations.

4. Prototype of a Reference Model
Management System

The RMMS-prototype presented in the following was
developed over a period of a year at the Institute for
Information Systems (IWi) at the German Research
Center for Artificial Intelligence (DFKI). The
development of the system was supported by the
“Deutsche Forschungsgemeinschaft” (German Research
Foundation) within the project “Reference Model-Based
(Reverse-) Customizing of Service Information Systems”
The ARIS-Toolset [1] was used as the basis modeling tool for the RMMS.

4.1. Project View

The graphic user interface of the RMMS is illustrated in Figure 2. The prototype, implemented in the platform independent programming language Java (http://java.sun.com/), differentiates between a project and a model view. The project view has been selected in the screenshot in Figure 2.

The RMMS work space is divided up into an explorer and a viewer. These are connected logically with each other – a project selected in the explorer is displayed in detail in the viewer and can be manipulated there.

The project active in Figure 2 is called “Reference Model for Event Management” and is used for the development of a reference model for the application domain “event management”. The title, the project’s customer segment, as well as information concerning the project period, progress and type were selected by the project manager while setting up the project with the help of the assistant (project wizard). This information can in addition, be modified using the buttons “Project” and “Subject”.

A detailed representation of the customer assigned to the activated reference modeling project, i.e. his or her address, branch of business, turnover, number of employees, range of products, etc. can be reached using the button “Customer”. This functionality also allows you to call up information such as customer description, goals or requirements. While this assignment in the use of reference models pertains more to individual customers, projects in reference model development are usually assigned an entire customer segment, as reference models are constructed for a whole class of use cases.

The viewer is divided up into index cards, which can be selected using their respective tabs.

The index card “Overview” (cp. Figure 2) basically characterizes the modeling projects. The elements in this card form important criteria according to which the projects stored can be sorted or searched.

Figure 2: Graphic User Interface of the RMMS
The index card “Activities” contains the tasks or activities necessary for the realization of the targeted reference modeling project. Furthermore, descriptions of the above, activity plans and hierarchies are also stored here. These tasks are individually assigned to project members (link to the index card “Members”), as well as to project documents, such as for example, meeting minutes or the presentation of results (link to the index card “History”).

The creation of the team, which will work together in realizing the reference modeling project, takes place using the index card “Members”. This card also contains the name, position, location, organizational unit and contact information for each member of the team, as well as the respective tasks assigned to them.

In addition to the project activities and employees involved in business engineering projects, one should also document information about the progress of the tasks, the problems met, as well as possible and ultimately selected measures for solving these problems. The history of the reference modeling project is therefore documented in a project history (“History”). This can be used by the project members as a source of information regarding the project history and can support the user in planning future projects.

4.2. Project Collaboration

The collaboration between employees in different departments and at different locations is also customary in the development and usage of reference models. Thus, the RMMS has functionalities which support collaboration during reference modeling projects. To this purpose, an asynchronous communication medium (discussion) is offered on the collaboration card. One is also given the possibility of reviewing project documents (cp. Figure 3).

In Figure 3, the topic “Event Management Framework” is open in the discussion forum. The RMMS-user can start a discussion about a new topic per textual contribution using the button “New”. Other users can then respond to this contribution with contributions of their own. The response is stored in connection with the original message in RMMS and can be called up at any time.

Figure 3: Project Collaboration
This form of communication is generally not used for time-critical topics and is known from internet-newsroups. Discussion forums attempt to reach the largest possible group of unknown addressees with competence in certain topics and approaches for solving certain problems.

4.3. Model View

The workspace in the RMMS-model view is also divided up into an explorer and a viewer (cp. Figure 4, screenshot in the background). In the model explorer, all of the information models managed by the RMMS are displayed. This pertains to reference models constructed in development projects, as well as enterprise-specific models created in projects, in which reference models are applied.

Figure 4: Interactive-Design between RMMS and the Modeling Tool

The index card system in the model viewer is used to manage the most important model related information for the management of reference models.

On the index card “Overview” of the model view, the information models managed by the RMMS are characterized. This is similar to the corresponding card in the project view. The elements of the card “Overview” provide criteria, similar to the corresponding information in the project view, according to which the information models stored can be sorted or searched. Potential sorting criteria, which can be selected in the corresponding pull-down-menu in the upper part of the model explorer are: branch of trade, model name, application domain, model developer, period of development, modeling progress and
modeling language. In the screenshot in Figure 4 the criteria “Economic Activity” is selected. The reference model selected, which due to its form is referred to as “Event-E”, is assigned to the branch “Marketing”.

A graphic representation of the model to be constructed in the modeling project is made possible with the card “Graphic”. Figure 4 illustrates the connected requirements clearly, as well as the resulting interactive-design between the RMMS and the modeling tool ARIS-Toolset. The example illustrates that the user can make modifications on a version of the reference model organizational framework for event-management. To do so, he must open the modeling tool by clicking the button “Edit”. In addition to reading, editing or deleting models and model elements, the business engineer is given further functionalities of the modeling tool.

The subject of the dialogue which can be reached using the button “Versions” on the graphic index card (cp. Figure 4), is the management of the models and model element versions (model history) created in the course of the reference modeling project. In addition to the most important model data, such as name, type or creation and modification dates, other data such as time, responsibility (link to the card “Members”), description, reason, priority and status of the model modifications, as well as the corresponding project activities (link to the card “Activities”) are recorded. The structure of this dialog is based upon the findings on the configuration management of information models [6].

The display of characteristic information, with which certain information models can be recognized, can be viewed on the index card “Attributes”. Similarities and differences between the models are emphasized and used for other activities (for example: similarity analyses, searches).

4.4. Collaboration and Distributed Modeling

The RMMS gives you diverse functionalities for the support of distributed reference modeling [25]. In the project view, these referred to the support of administrative project tasks, complemented by the asynchronous communication medium of the discussion forum. These functionalities have been extended by way of a synchronous communication medium on the index card “Collaboration”, a shared whiteboard for the interactive viewing and annotation of graphic data.

 Basically, a shared whiteboard is a computer-assisted medium of communication with which several people at different locations, connected to each other via a computer network, can develop graphics together simultaneously using a graphic program [5]. The graphics are transferred synchronously to the computers connected via the network.

By activating the button “New” the user creates a new whiteboard-discussion, to which he can invite (during the discussion) project members via an assistant or using the index card “Participants” (cp. Figure 5). At the same time, the RMMS generates a graphic of the model selected by the user in the model explorer. This is defined as a background in the drawing board of the collaboration card. In Figure 5 the current version of a process model for an event management strategy is shown.

Various tools are available to the user for annotating the graphics with text-based and graphic elements. In the use case, a user first expresses his lack of understanding as to why a part of the process, representing the definition of the so-called secondary target group, ends. The project member noticed this while navigating through the EPC-model “Event Strategy” in the ARIS-Toolset (cp. Figure 3). “Johann Spuling” asks, whether the event “Secondary target group is identified” must be connected with an AND-connector. To graphically visualize his question the user selected the “red pen” in Figure 5 and annotated the graphics with a circle, an arrow and a question mark. The project manager replies and justifies the absence of the edge with the fact that the secondary target group must no longer be included in the process preparations for the event and will, at a later point in time, be considered by public relations (PR)- or marketing activities. The “construction result” can be subsequently saved with the discussion for documentation purposes.

5. Conclusion and Further Research

Reference modeling has not yet established itself in business practice. This is due to the particular field of conflict between research and practice in which reference modeling is at home. Thus, there is still a deficit in knowledge about the use and problems inherent in the implementation of reference models despite the array of theoretical concepts. Accordingly, in the past years the development of supply-sided reference models predominant in the science world has distanced itself from their demand-sided use in business and administration. This article is devoted to this problem.
The rationale for the approach, “reference model management”, selected here is based on an analysis of the state of the art in reference modeling, whereby potentials were seen in two respects. First, we have shown that the contributions at hand comprehensively address the design of construction results, but however disregard the corresponding construction processes which makes the retraceability and thus, the reuse of the results difficult. On the other hand, results pertaining to the design of the construction processes are available, concentrate however, either on the development or the use of the reference models or they do not sufficiently reduce the chronological, contextual and organizational separation between both processes.

Reference model management was therefore formulated explicitly with the purpose of recreating the connection between the separated processes in reference model development and usage. Thus, within the framework of a process-oriented interpretation, the integration of both processes has been identified as a third function in reference model management next to the development and usage of reference models. The design and realization of an information system for the management of reference models were concretized as objectives here because, due to the magnitude of the models in modeling projects, the economic construction and use of models is only possible with the help of IT-tools. The development of this information system referred to as reference model management system (RMMS) was structured by a framework.

The knowledge won in this analysis can be used as a starting point for more detailed research work. Thus, for example, empirical studies could be made to investigate whether the insights won more or less deductively coincide with the reality of business practice. One could also investigate how the use of the RMMS affects efficiency in modeling projects. The investigation of the effects of this prototype in operational business reality is seen as a future challenge for the author in his research activities.
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