Data Warehouse Design and Legal Visualization : The Applicability of H2 for Reporting

Joerg Becker
University of Muenster - ERCIS, joerg.becker@ercis.uni-muenster.de

Mathias Eggert
University of Muenster - ERCIS, mathias.eggert@ercis.uni-muenster.de

Stefan Fleischer
University of Muenster - ERCIS, stefan.fleischer@ercis.uni-muenster.de

Marcel Heddier
University of Muenster - ERCIS, marcel.heddier@ercis.uni-muenster.de

Ralf Knackstedt
University of Muenster - ERCIS, ralf.knackstedt@ercis.uni-muenster.de

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Jörg Becker
ERCIS
University of Muenster
Muenster, Germany
Email: joerg.becker@ercis.uni-muenster.de

Mathias Eggert
ERCIS
University of Muenster
Muenster, Germany
Email: mathias.eggert@ercis.uni-muenster.de

Stefan Fleischer
ERCIS
University of Muenster
Muenster, Germany
Email: stefan.fleischer@ercis.uni-muenster.de

Marcel Heddier
ERCIS
University of Muenster
Muenster, Germany
Email: marcel.heddier@ercis.uni-muenster.de

Ralf Knackstedt
ERCIS
University of Muenster
Muenster, Germany
Email: ralf.knackstedt@ercis.uni-muenster.de

Abstract

The steady increase of regulations and its acceleration due to the financial crisis heavily affect the management of regulatory compliance. Regulations, such as Basel III and Solvency II particularly impact data warehouses and lead to many organizational and technical changes. From an IS perspective modeling techniques for data warehouse requirement elicitation help to manage conceptual requirements. From a legal perspective attempts to visualize regulatory requirements – so called legal visualization approaches – have been developed. This paper investigates whether a conceptual modeling technique for regulatory-driven data warehouse requirements is applicable for representing data warehouse requirements in a legal environment. Applying the modeling technique H2 for Reporting in three extensive modeling projects provides three contributions. First, evidence for the applicability of a modeling technique for regulatory-driven data warehouse requirements is given. Second, lessons learned for further modeling projects are provided. Third, a discussion towards a combined perspective of information modeling and legal visualization is presented.

Keywords

Legal Visualization, Regulatory Financial Reporting, Compliance, Conceptual Modeling, Data Warehouse.

INTRODUCTION

The number of regulations that are imposed on companies steadily increases. At the same time compliance management becomes more and more business critical and complex. This development was even accelerated by the world economy crisis in 2008. According to an industry study of 2005 among executives in 1,300 international organizations, regulatory compliance became more important than defeating worms and viruses (Ernst & Young 2005). In an empirical study among Australian compliance experts Abdullah et al. (2010) identified several open research topics. One of the identified challenges is the “lack of communication among staff” which directly refers to the ability to communicate regulatory requirements in a way that compliance can be achieved.

Compliance management can be supported by integrating legal requirements into conceptual models of business processes in workflow management systems, data warehouses, or other information systems. Some techniques that have already been proposed for this are annotations of regulatory requirements (Schleicher et al. 2011) or logical expressions to verify the regulatory compliance of process models (Goedertier and Vanthienen 2006). In this paper we argue for modeling regulatory requirements as a means to support communication between IS designers and legal experts. Applicable modeling techniques need to represent all relevant legal requirements in order to explicate them so that they can be considered in IS design processes. So far, the applicability of such modeling techniques for the representation of regulatory requirements remains an open research area.

The paper at hand discusses the need for modeling techniques that are able to represent legal requirements. Therefore, we argue for the relevance of adapting the idea of *legal visualization* for IS design. In order to prove this relevance we analyze regulatory reporting requirements in the financial service industry. Therefore, we conducted three different modeling projects, where a modeling technique for data warehouse modeling (which was adapted to also represent legal requirements) was used to model three different regulatory frameworks.

The remainder of this paper is as follows. The next section summarizes related work on legal visualization, data warehouse and report modeling. This section explicates the requirements for a combined perspective of IS and law. In the subsequent section we briefly describe our research design and experiment setting before we present the results of three modeling projects aiming to develop conceptual models for regulatory requirements. Based on our experiences in these modeling projects we then report lessons learned for further modeling projects. In the last section we discuss the findings, provide contributions for research and practice, and give an outlook.

RELATED WORK

Legal Visualization and Information Modeling

Information models provide comprehensibility of and support communication on complex real world situations (Kung and Sölvberg 1986; Mylopoulos 1992). Such models have proven very successful in supporting communication on requirements between actors from a technical perspective (e.g., systems developers) and actors from an organizational perspective (e.g., managers). It was shown that communication between different stakeholders is the main reason why practitioners use conceptual models (Davies et al. 2006).

Current developments in regimentation (e.g., reporting regulations in the wake of the financial crisis) more and more emphasize the need for considering legal requirements (in addition to organizational and technical requirements). Therefore, it is imminent that information modeling techniques get capable of (somehow) depicting legal regulations in order to foster communication on legal requirements between legal experts (e.g., corporate lawyers) and legal laypersons (e.g., systems developers, report designers, or managers).

Visualization of knowledge in general comes along with several advantages, which further indicates the need for visualizing legal knowledge in information systems models. Visualizations can support communication of knowledge workers, raise awareness, improve the memorability, have a motivating impact on the viewer, provide deeper understanding of concepts and ideas, and reveal previously hidden connections (Eppler and Burkard 2004).

When asking the question ‘How to visualize law in information modeling’, it is reasonable to draw from existing visualization methods and approaches. A lot of visualization methods for the purpose of knowledge visualization have been developed for different purposes and different stakeholders. These methods can be categorized into certain dimensions (Lengler and Eppler 2007). First, visualization methods exist for different application areas like data visualization, information visualization, concept visualization, metaphor visualization, strategy visualization, and compound visualization. Second, they can be differentiated by the level of abstraction. They can provide an overview, get into detail, or enable both, an overview and a detailed view. Third, they can be distinguished by the cognitive process they support, which is convergent thinking (articulate implicit knowledge) or divergent thinking (stimulate new knowledge). Fourth, they can be either depicting a structure (hierarchies, networks, etc.) or a process (Lengler and Eppler 2007).

How these approaches can be adopted to visualize legal knowledge is investigated in a field of research in jurisprudence called “Legal Visualization”. This research area tries to make legal content (e.g., laws, policies, contracts) more comprehensible for legal laypersons by means of visualization. A slow but steady pictorial turn can be observed in legal culture (Hibbitts 1996). The field covers a broad range of methodological approaches. On the one hand there are rather pictographic images of legal situations or concepts (Brunschwig 2011). These visualizations need to be custom made for a specific situation and usually provide an overview without too much detail. On the other hand there are more structured approaches like using or modifying process modeling techniques in the legal context (Olbrich and Simon 2008).

The challenge is to combine approaches from legal visualization with approaches from the IS field. In this paper we conducts first attempts to apply legal visualization in an IS context. That means to apply an enhanced data warehouse modeling technique with constructs for legal requirements resulting from reporting regulations.

Data Warehouse and Report Modeling

A variety of modeling techniques for representing conceptual requirements for data warehouse-based OLAP systems (Chaudhuri and Umeshwar 1997) have been developed (Rizzi et al. 2006). Classical modeling techniques are established for the conceptual design of relational databases and operational applications, such as the entity-relationship-model (Chen 1976) or the object type method (Wedekind 1979). These techniques enable the definition of reference object structures in hierarchies and hierarchy levels, according to which quantitative information (ratios, measures, metrics – in the following we use the synonym ratio) needs to be analyzed. Extensions of classical data modeling approaches modify the established data modeling techniques, therefore paying greater attention to ratio relations (ratio systems), modeling of relation objects (dimensions) and modeling of concrete objects (instances). Modeling approaches that solely focus on the representation of multi-dimensional constructs extend existing data modeling approaches, such as ME/RM (Sapia et al. 1998). Other modeling approaches are derived from the field of scientific and statistical databases which deal with the specification of multi-dimensional data spaces since the eighties. Extended object-oriented modeling approaches are also proposed for the specification of data warehouse data. Some of these approaches are targeted at extending the Unified Modeling Language (Booch et al. 2005).

The established modeling approaches do not or only insufficiently consider the modeling of legal principles within the conceptual design of data warehouse systems. Advanced approaches were proposed by Goeken and Knackstedt (2008; 2009), and Knackstedt et al. (2012). Goeken and Knackstedt extended the ME/RM modeling technique (Sapia et al. 1998) to model regulatory compliant reports for the financial sector (Goeken and Knackstedt 2008; Goeken and Knackstedt 2009). Knackstedt et al. (2012) developed a modeling technique extension of H2 for Reporting, a multidimensional modeling technique for data warehouses and report definitions. Both modeling techniques were developed in order to support the requirement definition for regulatory-driven financial reports. However, so far the evaluation of such approaches remains open in IS research. This paper seeks to address this research gap.

RESEARCH DESIGN

In order to demonstrate the applicability of regulatory-driven data warehouse and report modeling we conducted three extensive modeling experiments. The overall goal is to show that conceptual modeling techniques, such as H2 for Reporting (Knackstedt et al. 2012) or equivalents, are able to represent regulatory requirements and thereby support legal visualization in the domain of information systems. Therefore H2 for Reporting was extended with constructs that enable the representation of regulations (Knackstedt et al. 2012). The visual representation of these constructs was adopted from the field of *legal visualization* (Mahler 2009). The rationale behind is that the ability to represent all regulatory requirements is the foundation of supporting communication processes among IT experts and legal experts. Thus, we investigate whether data warehouse modeling constructs of a common modeling technique (H2 for Reporting) are able to represent regulatory requirements for supervisory reports.

Data Collection

The three modeling experiments aim to design conceptual models for regulatory-driven financial reports, based on the German liquidity act (for reporting of banks' daily, monthly and quarterly liquidity)[1], the large exposure act (for steady reporting of large and million loans)[2], and the new Basel III report requirements (new framework for banks' equity requirements)[3]. We selected these three regulations based on their high importance for banks. We expect that in particular the third version of the Basel framework will have heavy impacts on financial industries. However, for demonstrating the need for legal visualization approaches in IS, all three regulations provide many good examples.

All modeling experiments were conducted in 2011. While the liquidity act is a rather small regulation, the large exposure act and Basel III regulation are quite extensive. Thus, more staff to develop corresponding conceptual models was required. The liquidity act was modeled by one student while the other two regulations were modeled by two groups of five students each. All students were in the sixth bachelor semester and received a two-day workshop on conceptual data warehouse engineering and the usage of H2 for Reporting (Knackstedt et al. 2012) beforehand. After that workshop we evaluated the modeling skills by several exam tasks. The results have shown that all participants had a fair knowledge in data warehouse modeling and in analyzing regulatory requirements.

All students received the meta modeling tool H2-Toolset (Janiesch 2007), which enables the development of hierarchical models for report and data warehouse requirement elicitation. In Appendix A we provide an overview about all modeled basic data warehouse constructs, such as dimensions, ratios, ratio systems, reference objects, and cubes. Appendix B contains the extended constructs, such as fact calculation, reference object attribute, and dimension scope. Appendix C offers an overview about all report modeling constructs (report, report layout, report attribute, and filter) and Appendix D provides all regulatory extensions, such as external/internal regulation, deontic function, non-deontic function, regulation-element relation, and validity.

[1] For details see http://www.bafin.de/SharedDocs/Aufsichtsrecht/EN/Verordnung/liqv_en_ba.html.
[2] For details see http://www.gesetze-im-internet.de/gromikv_2007/index.html.
[3] For details see http://www.bis.org/publ/bcbs188.pdf.

Data Analysis

After the creation of these three models, we analyzed them in order to get insights into the appearance and usefulness of the corresponding modeling constructs. Since the applied modeling tool uses a MySQL database, we used database queries in order to count the appearance of the different modeling constructs. Based on these query results we prepared a table that compares the counts of all constructs sorted by the categories *basic data warehouse concepts*, *basic concept extensions*, *extensions for report representation*, and *extensions for regulation representation*. We count the appearance of all modeling constructs and discuss them briefly.

FINDINGS

In the following we present the results of the three modeling experiments. All results are presented in Table 1. Figure 1 depicts an example for a modeled report required by financial reporting requirements of Basel III. It depicts conceptual requirements for an equity report. Two dimensions are used (Control and Equity Category). The major ratio of that report is the Carrying Amount which contains the rated equity. Two (visible) regulatory requirements are linked with that report (IAS 1.IG6 and IAS 1.54(q)). Furthermore the report contains two row sections (Controlling interests and Non-controlling interests). Each one contains a filter on the control dimension and provides dimension scopes. Finally, the report model contains a report attribute (frequency = monthly). The whole report template was developed based on regulatory requirements and provides just one example for altogether 71 reports that have been developed by the modeling project teams.

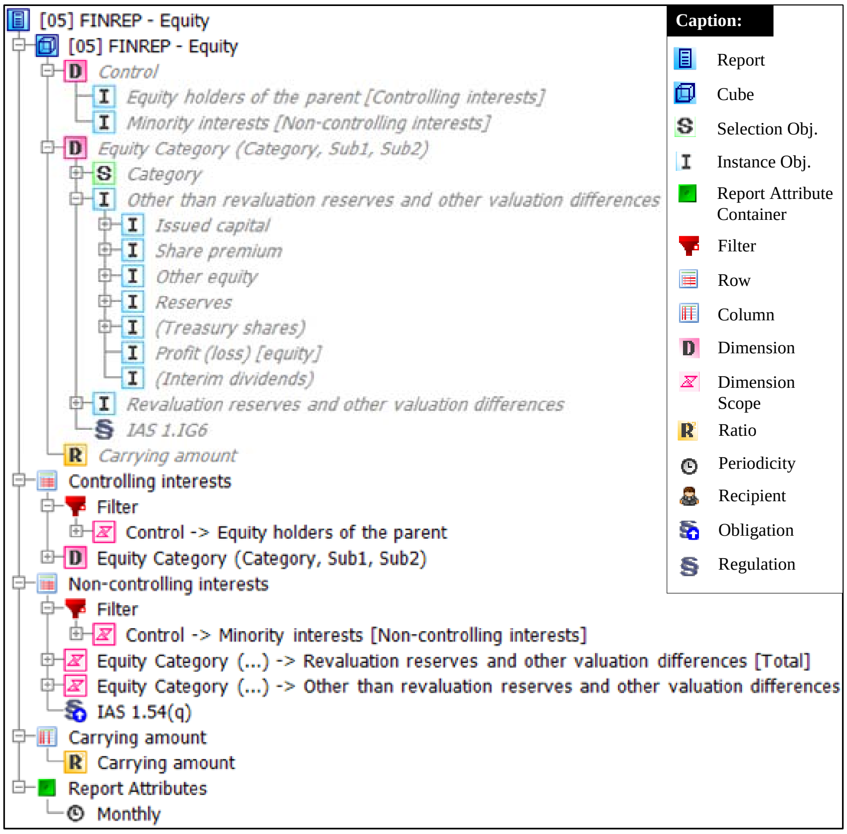

Figure 1: Basel III equity report model excerpt

The teams could decide how to model the regulations, which led to different modeling strategies. The students that were modeling the liquidity act and Basel III focused solely on the relevant parts for data warehouse and reporting requirements while the project team that developed the model for the large exposure act modeled all regulations, even if they were not explicitly relevant to reporting (e. g., qualitative norms). Therefore, the large exposure act group created more regulation elements (relative to the size of the regulation).

In all three modeling projects *basic data warehouse constructs* are used frequently. Altogether 139 reference objects, nine dimensions, 16 ratios, six ratio systems and one cube have been modeled to conceptually represent the requirements of the liquidity act. The large exposure act is more complex and covers more reporting details. Consequently, more basic data warehouse constructs are necessary to develop a conceptual model for these regulatory requirements. Therefore 152 reference objects, 12 dimensions, 69 ratios, 21 ratio systems and 13 cubes have been modeled. The large number of ratios and fact calculations is necessary because of the complex calculation of the ratios. The loans need to be rated among the probability of default which in turn is depending on the loan securities which again need to be rated. The most extensive regulation is the Basel III framework which results in 1107 reference objects, 93 dimensions, 117 ratios, eleven ratio systems, and 46 cubes. All in all the project teams developed 14 models in order to represent the Basel III report requirements. They structure the models among the basic columns of Basel III (Liquidity Coverage Ratio, Net Stable Funding Ratio, Minimum Capital Requirements, Financial Reporting, the modules A to D, as well as Market Risks).

The usage of *extension concepts*, such as dimension scopes, fact calculations, and reference object attributes, show a similar distribution. The small number of used reference object attributes, such as customer ID, forename and surname in a customer dimension, is conspicuous. One reason might be the vague description in the observed legal principles. In many cases the law does not directly provide any concrete requirements about necessary attributes. In terms of the liquidity act reference object attributes can only be found in the appendix section which was not in the focus of this modeling project.

Extensions for report representation have been used in all three projects and for all supervisory regulations. The requirements of the liquidity act have been modeled by using three reports, 19 report layout elements and 18 report attributes. Reports in order to fulfill requirements of the large exposure act have been modeled by the use of 23 reports and 50 report attributes. Compared to the other two regulations the large exposure act does not provide detailed requirements about the report layout. Thus, the project team did not provide any report layout requirements in the conceptual model. The Basel III project team again developed the most extensive models. Interestingly, they used only two report attributes which again indicates that the core regulations only provide vague report representation requirements.

Table 1. Results of modeling experiments

			Liquidity Act	Large Exposure Act	Basel III
Basic Data Warehouse Concepts	Reference Object		139	152	1107
		Selection Object	22	13	172
		Instance Object	117	139	935
	Dimension		9	12	93
	Ratio		16	69	117
	Ratio System		6	21	11
		Mathematical	6	14	10
		Logical	0	7	1
	Cube		1	13	46
Exten-sions	Dimension Scope		57	56	376
	Fact Calculation		80	59	117
	Reference Object Attribute		0	0	6
Extensions for Report Representation	Report		3	23	45
	Report Layout		19	0	410
		Rows	15	0	305
		Columns	4	0	105
	Report Attribute		18	50	2
		Recipient	9	28	1
		Periodicity	9	22	1
	Filter		0	0	164
Extensions for Regulation Representation	Regulation		191	538	739
	Deontic	Obligation	30	64	291
	Deontic	Exemption	16	14	17
	Deontic	Prohibition	0	14	14
	Deontic	Permission	2	30	23
	Non-deontic	Qualification	68	128	141
	Non-deontic	Power	0	10	0
	Non-deontic	Other	75	278	253
	Regulation Element Relation		184	535	716
		Consists of	153	129	716
		References	31	406	0
	Validity		164	294	881
	Validity Attribute		32	22	0

The three modeling projects make use of *extensions for regulation representation*. 75 (unqualified) regulations, 48 deontic, 68 non-deontic regulations, 184 regulation element relations, 164 validity relations, and 32 validity attributes have been used to conceptually represent requirements of the liquidity act. With the usage of 739 regulation elements in total the Basel III model is the most extensive one. In relation to the overall model size the second project team modeled most regulations, which in turn is a consequence of its modeling strategy (They decided to analyze each sentence of the large exposure act). Thus, the relative number of modeled regulations is much higher compared to the other models of the liquidity act and Basel III. Analyzing the element occurrence it could be observed that the non-deontic element ‘power’ was not used in two of three models, which leads to two possible explanations. Either ‘power’ is not a suitable element to model supervisory reporting requirements or the concept behind this construct is too difficult to grasp. Further modeling projects need to be conducted in order to confirm these assumptions.

In all project teams the requirement to define a formal equation language in order to represent if-then-else statements has been discussed. For example, the liquidity act requires the calculation of a liquidity ratio that should not fall below the value of zero: “The liquidity of an institution shall be deemed to be adequate if the liquidity ratio to be calculated does not fall below the value of one” § 2, section 1, liquidity act. To represent such regulation it is necessary to define a syntax that enables formula descriptions. Furthermore, we experienced the need to define keywords that are related to deontic functions. By doing so group three was able classify the Basel III regulations faster than the other groups. In the following we present the lessons learned experienced during the modeling projects.

LESSONS LEARNED

The three modeling experiments provide evidence that regulatory-driven data warehouse engineering could benefit from modeling techniques that represent regulatory requirements. Except the concepts of ‘power’ and ‘reference object attributes’ all modeling technique elements were applied frequently. Furthermore it turned out that report layout definitions are not always included in regulatory requirements. This is due to the type of the analyzed regulations, which are all at an aggregated level. The so called legal guidelines enable more detailed requirements for report definitions. However, much was learned about the analysis and modeling of regulations, which we summarize in the following five lessons learned.

First, for IS students it is particularly difficult to understand the domain knowledge. While the liquidity act modeler and the Basel III group did not prepare a domain term repository, the large exposure act group first identified all unknown terms and prepared a dictionary. This in turn increased the understanding of the regulatory requirements. The other modeling groups had much more problems in understanding the domain terms. Thus, it is important to get background knowledge and term definitions before the beginning of the actual modeling.

Second, for all participants it was challenging to identify data warehouse constructs out of the legal texts. Expressions, such as “[…] for each of the three categories above […] there is a single set of criteria that instruments are required to meet before inclusion in the relevant category”, I.A.49 Basel III (Definition of Capital), are quite hard to identify as dimension. In addition it was reported as challenging to separate between a ratio and a dimension definition. One useful procedure for simplifying the identification of relevant legal expressions is to prepare a repository for common expressions and to particularly train the modelers in the identification of modeling constructs. Students report that to some extend it would have been necessary to implement more exercises for identifying relevant data warehouse concepts.

Third, we identified a couple of regulations that are not directly transferable to data warehouse concepts but at the same time cannot be neglected. One example is the definition of variables and functions. The liquidity act contains paragraphs in which a function is described (cp. § 2, section 2, liquidity act). According to this regulation the liquidity ratio is not allowed to fall below the value of zero. This requirement is relevant for reporting but cannot be expressed by current modeling constructs. Thus, a modeling language extension might be a suitable solution. During the modeling projects all participants prepared a modeling handbook in which they explicated how they proceeded with such regulations and how they would extend the modeling technique.

Fourth, it turned out that interrelations between regulations are of major importance in order to establish a link between regulatory requirements and the conceptual model. During the modeling projects the question came up how to proceed with references to other laws. Since a link to all referring laws would decrease the clarity of the models it was decided to include inter-law references only when relevant constructs were defined. For example, the large exposure act contains a reference to the banking act in order to link to the definition of off-balance transactions (“[…] other off-balance transactions according to § 19 section 1 Sentence 3 of the banking act […]”, large exposure act, § 2, Section 1, No. 8). Such regulatory references were modeled as ‘qualification’ and, thereby, added the corresponding paragraph of the banking act to the dimension “off-balance transactions”. Other references were not modeled in order to keep clarity and simplicity of the model.

Fifth, the modeling granularity is another issue that legal visualization approaches are faced with. The large exposure act group decided to model each sentence of the regulation and determine its deontic function regardless of its relevance for data warehousing. While on the one hand such a procedure needs much effort it is on the other hand meaningful for a suitable regulation repository and structure of which the students could then select the right regulatory element and annotate it to the data warehouse concepts. In a first step the deontic classification of each sentence was done, while the annotation follows in the second step. The Basel III group had serious problems to identify the deontic functions after the annotation to data warehouse concepts. Based on these experiences we suggest following the sentence-by-sentence procedure.

DISCUSSION AND OUTLOOK

In this paper we have shown that visualizing (modeling) legal requirements of reporting regulations is a topic of increasing relevance, has several potential benefits and is applicable. The feasibility was shown in three modeling projects where three different regulatory frameworks have been modeled with an extended data warehouse modeling technique. The results and the lessons learned show that nearly all constructs of the applied report modeling technique H2 for Reporting were necessary in order to model the three regulatory frameworks. We observed that different modeling strategies lead to different results (sentence-by-sentence vs. paragraph-based approach) and that a common understanding of the terms in a legal regulation helps to model it collaboratively. It was also elaborated that there is still potential to extend the modeling technique even further, because some parts of legal regulations (e.g., the definition of functions or variables) could not be modeled due to missing modeling language constructs. We further observed that it is important to find the right degree of referencing legal norms, so that every relevant norm is referenced but the simplicity of the model remains preserved.

The paper’s contribution to research is threefold. First, as one of the first attempts to combine legal visualization approaches with information modeling, we could evaluate the necessity of such modeling approaches. The three modeling experiments provide evidence that it is possible to conceptually model regulatory report requirements. Second, we contribute to the evaluation of a conceptual modeling language that is suitable to develop conceptual information models for report requirements. The modeling experiments and its statistics prove that many language constructs really exist in regulations. Third, we contribute to the interdisciplinary transfer of research results from legal visualization to IS research. By conducting such modeling experiments for the conceptual requirement definition of regulatory-driven reports, we investigate the potential of an interdisciplinary research area at the border of legal visualization and information systems.

The paper contributes to practice by providing insights into conceptual requirement specification projects for the management of regulatory reporting requirements. We provide some of the challenges that IS designers are faced with when designing regulatory-driven information systems. The experiences from the three projects are in particular relevant for regulated financial institutions which are faced with reporting obligations and need to conceptualize their reporting system landscape. In projects that aim to elicit regulatory reporting requirements the provided insights into the modeling projects might be of major importance.

The implications of the conducted modeling experiments are limited. Since we had quite heterogeneous groups, we could not test whether these groups have similar skills, for example background knowledge in the banking industry. Even if all participants are in the fifths or sixth semester, there might be differences within the group of participants. In addition the participating students applied different modeling strategies, like described above. Thus, the modeling results of the three projects are not fully comparable to each other. Since our goal is to demonstrate that the constructs are needed (or not) for modeling regulatory data warehouse requirements comparability is of minor concerns.

The paper at hand opens several new research questions that can be structured in two directions. One direction is design science oriented and contains on the one hand the ongoing development of modeling techniques for reporting and regulatory-driven business processes. On the other hand design science oriented research should focus on analysis approaches in order to trace regulatory changes and its impact on reports, data warehouses and business processes. First attempts in this direction have already been done e.g. by Ly et al. (2009). The second direction is behavioral science oriented and may investigate the efficiency and effectiveness of applying modeling techniques for regulatory-driven IS design and requirements elicitation as well as investigate the perceptions of legal and IS experts in collaborative IS design projects. Considering these two research directions further research is needed on the potential of an integrated view on legal visualization and information modeling.

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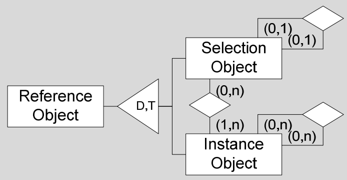
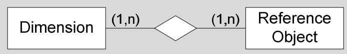
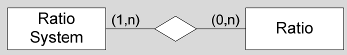
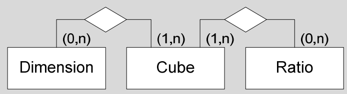
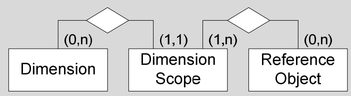
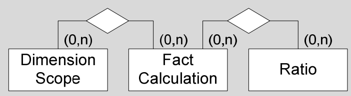
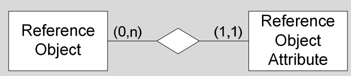
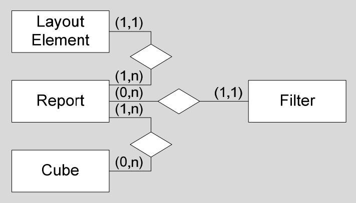
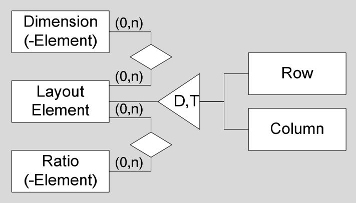
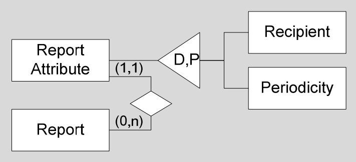
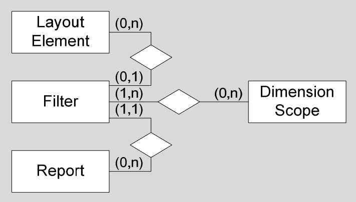
APPENDIX A: BASIC DATA WAREHOUSE CONSTRUCTS

Concept	H2fR Symbol	Linguistic Action and Statement	Meta-model Construct
Reference Object		Reference objects are the dimensions' elements the management's relevant space is made of. The two types of reference objects: selection objects describe the hierarchies of the instance objects and can be used as „proxy" for the instance objects.	
Dimension		Dimensions are used to create and organize the space of managerial analyses.	
Ratio		Ratios are instruments to measure management relevant aspects of the value of an enterprise, the business performance, and the financial situation.	
Ratio System		Ratio systems are sets of ratios, which enable the analysis of meaningful aspects of business situations. The ratios of a ratio system are hierarchically structured with respect to mathematical or logical relations.	
Cube		Cubes are multidimensional constructs containing facts. A fact is the concrete value of a ratio depending on the relevant reference objects (the value is aggregated over the non-relevant reference objects).	

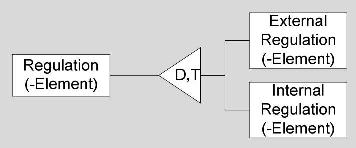
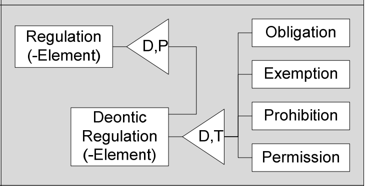
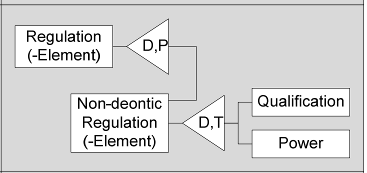
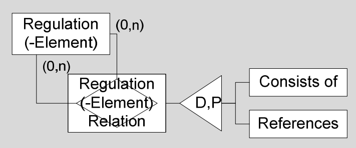
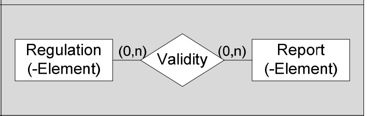
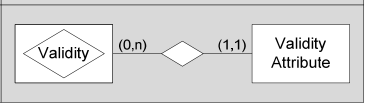
APPENDIX B: EXTENDED DATA WAREHOUSE CONSTRUCTS

Concept	H2fR Symbol	Linguistic Action and Statement	Meta-model Construct
Dimension Scope		A dimension scope limits a certain dimension to receive only information that is relevant for the current purpose.	
Fact Calculation		The combination of distinct reference objects applied to one certain ratio results in a concrete value, the fact. The fact calculation construct determines how certain facts are calculated.	
Reference Object Attribute		Reference object attributes can be assigned to reference objects to indicate that certain information must be provided by a reference object (e.g., the customer number).	

APPENDIX C: REPORT EXTENSIONS

Concept	H2fR Symbol	Linguistic Action and Statement	Meta-model Construct
Report		Reports represent the output of a data warehouse and reporting system. They comprise cubes that deliver the data for a report. A report can be seen as the two-dimensional projection of a multidimensional cube. Layout elements provide the structure for a report. Filters might be applied to limit the cube data as input for the report (possibly because of policy restrictions or just for analysis purposes).	
Report Layout		Report layout elements such as rows and columns can be assigned to a report to describe the structure of a report. Rows and columns can contain dimensions (or dimension scopes or single reference objects) or ratios (or ratio systems or fact calculations) to specify the structured content of the report.	
Report Attribute		Report attributes further describe the properties of a certain report. Two of the major attributes are the report recipient and the periodicity of a report. Other attributes are also conceivable (e.g., report type or medium).	
Filter		Filters enable the limitation of data that comes from the cube into the report. Filters can be applied to a complete report or to single layout elements.	

APPENDIX D: REGULATORY EXTENSIONS

Concept	H2fR Symbol	Linguistic Action and Statement	Meta-model Construct
External/ Internal Regulation		An external regulation explicates that the belonging regulation contains requirements that come from outside the organization (e.g., laws or directives). Internal regulations are organization-specific requirements that possibly concretize or individually interpret external regulations: If the law gives a certain design freedom, the internal regulation might be its specialization.	
Deontic Regulation		Regulations can be classified based on their deontic function: This approach explicates whether a regulatory element is an *obligation*, an *exemption*, a *prohibition*, or a *permission*. Not all regulatory elements can be allocated to deontic functions (see *Non-deontic Regulation* below).	
Non-deontic Regulation		Regulatory elements that cannot be allocated to deontic functions (see *Deontic Regulation* above) can be used, for example, for defining which situations have to be understood under specific legal concepts (*qualification*) or allocating competencies to executive institutions (*power*).	
Regulation Element Relation		A regulation (-element) may consist of further regulation elements (e.g., sections, paragraphs, sentences). Regulations may also reference each other: An internal regulation might be the concretization or the organization-specific interpretation of an external regulation. Or a German law represents the implementation of a European directive.	
Validity		A regulatory element assigned to a report or a report element (e.g., dimension, reference object, ratio) forms a validity. Thus, a validity is the relation between a report (-element) and a regulatory element.	
Validity Attribute		Validity attributes can be assigned to validities to specify additional aspects, for example, temporal validities: § 13 of the German Liquidity Act states that the German Liquidity Act comes into effect on 1 January 2007.	

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