Merging Conceptual Modeling and Law for Legally Compliant Information Systems Design – A Framework-Based Research Agenda

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Abstract
Legal regulations play an important role in the design of information systems and their related organizational systems. A legal assessment subsequent to the system’s development can demand expensive modifications or even the need for replacing existing systems. Legal infringements and resulting disputes can permanently damage an organization’s image. To avoid these problems, we argue for the consideration of relevant legal regulations as early as the design phase of systems development. Conceptual modeling has proven to be an optimal instrument for system designers. In this paper, we propose a framework-based research agenda for the improvement of conceptual modeling for the explication and communication of legal requirements. We then show exemplary how the framework can be used by researchers to classify existing research results or to derive new research questions in the field of designing legally compliant information systems.

1. Introduction

The relationship between Information Technology (IT) and Law is often perceived as conflict laden. Highly complex and incomprehensible IT development contracts, e.g., may lead to disputes resulting from fundamental misunderstandings and therefore, may lead to additional costs and diminished trust between contractual partners. IT innovations and the resulting enablers for innovative business processes and business models are frequently forestalled or even prevented by legal regulations (e.g., [11]). The implementation of internet applications leads to cease-and-desist orders. Data privacy scandals threaten a company’s image. Subsequent changes in software systems that are made due to the existence or modification of relevant legal regulations are expensive. In summary, we state that the development of information systems and their legal assessment are in many cases insufficiently synchronized.

In contrast to that, the early integration of business requirements into IS development has proven to be effective and efficient. The alignment of IT with the requirements of the business world has been thoroughly examined under the headword IT alignment [38, 24]. IT in turn impacts the business world through IT innovations [14], like e.g., service oriented architectures (SOA) that should fulfill the requirements in a better way or even act as enablers for business innovation and new business models [25]. An early inclusion of managers during software development in the context of requirements engineering has proven highly effective [54, 13, 46]. Thereby, the different stakeholders communicate on the basis of conceptual models about the requirements and changes of an information system and the underlying organizational system (Business processes, business models). The software solution is developed only after reaching a consensus. It is helpful that paradigms like process orientation are shared in both disciplines (business administration and information systems).

Increasing effectiveness and efficiency in Information systems development needs a more intensive collaboration of IT and law. Legal feasibility is often assessed in a feasibility study prior to a software development project or in a subsequent legal assessment. This should be supplemented by a more synchronized incorporation of legal requirements. Current research on the intersection of IT and law does not fulfill these demands. It is limited to the legal assessment of already applied information systems or to the development of so-called legal information systems (i.e., legal document management software or databases), which are designed for jurists to facilitate their work (e.g., [43]). A fundamental interdisciplinary exchange between IS and law is not supported by this research.

The development of interdisciplinary applicable means of communication for IT and law is the basis for achieving the goal of synchronizing these fields.
IT and law must be able to share information about future use cases of the information system in an early development phase. To develop means of communication for this purpose is a research task, which has the potential to combine mostly separated and isolated research directions from the two disciplines that can mutually benefit from their different ways of thinking. On the IT side, an enhancement of existing common modeling techniques can be achieved by taking legal experts into account. While conceptual modeling is already established with regard to the involvement of business experts, the potential for using conceptual modeling in the context of legal regulations gets far too little attention. On the legal side, previously isolated approaches to visualization will be advanced by combining them with established principles of conceptual modeling. The young field of legal visualization can in particular benefit from the methodological basis for the development and evaluation of information systems modeling techniques.

The remainder of this paper is structured as follows: Section 2 provides some theoretically grounded arguments for the importance and feasibility of considering legal regulations in information systems design. In Section 3 we then propose a framework that we use to derive a research agenda for conceptual modeling of legally compliant information systems. The developed research framework addresses academics and is primarily designed to classify IS artefacts considering legal regulations. Its exemplarily application will be demonstrated in Section 4. It is shown that the framework can be used to classify existing research approaches or to derive new and unexplored research questions in the field of conceptual modeling of legally compliant information systems. Section 5 summarizes our results and concludes the article.

2. Information Systems Modeling and Legal Regulations

When thinking of representing law in or with conceptual models, we first of all have to think about the general problem of visualizing legal regulations. The visual representation of law is a topic intensively discussed in the legal domain. Different approaches are proposed by legal researchers under the headwords ‘legal visualization’. Still, there is a widespread abstinence from graphical depictions in law. One exception to this, with a long tradition, is traffic law. Signs are fundamental for the regulation of road, rail, and boat traffic. E.g., new ways to optimize the communication of rules with new types of signs are discussed in the field of legal visualization. A fast and direct conception of prohibitions, prescriptions, permissions, and exceptions is particularly important in traffic situations and ‘an image is (at least in theory) decipherable and immediately comprehensible’ [51]. Furthermore, it is known that some lawyers tend to complement their contract negotiations with selected representational forms. Depictions of timelines, for example, are utilized to demonstrate periods of termination or extension described in contracts [9]. In the sense of ‘proactive law’ [45], these measures can help to avoid later disputes that result from misconceptions and fallacy. More and more, governments utilize visual means for communicating legal regulations to their citizens. Some U.S. cities provide brochures that visualize the law for setting up a stall in front of shops [32]. Especially in the field of e-Government, numerous approaches depict administrative regulations as process models [2]. None of the approaches aim to replace textual law; it is rather argued that law should build up the necessary competencies for developing and using additional forms of representation to improve its comprehensibility – particularly in interdisciplinary constellations. The fact that the development of such approaches, despite their usefulness, is rather rare, that they have been developed relatively independent from each other, and that the approaches for developing them are rather heterogeneous illustrate that law still faces the challenge to establish a general theoretical foundation for designing additional representation forms in law. Therefore, drawing on theoretical foundations of conceptual modeling can be a valuable contribution to these developments. The systematic construction of representational forms and their documentation with meta models is a vital approach that has not attracted the attention of legal visualization researchers, although it could be of great importance for the creation of a common ground for communication.

In the following we provide theoretically grounded arguments that emphasize the relevance of an integrated perspective of information systems modeling and legal requirements.

Software implementation and development processes are often connected with expert and user involvement [4, 30, 37, 53] and formal methods for conceptual system design satisfaction [41, 50]. High quality conceptional work is fundamental for an early detection and correction of system planning mistakes [52]. Thus, it seems reasonable to consider legal requirements, like e.g., data privacy regulations,
reporting requirements, or copyright regulations, during the conceptional modeling phase. The consideration of reporting regulations and its transformation into data warehouse structures is a challenging task.

To make two people working together, it takes a coordination of content and a coordination of process. They cannot begin to coordinate their content before they prepare a “vast amount of shared information”, the so-called common ground [15]. According to Clark and Bremon [15], common ground describes mutual knowledge, mutual beliefs and mutual assumptions. Compliance experts as well as system engineers have to work together which causes communication problems when there exists no common grounding [15].

Conceptual models describe the physical and the social world to understand and support communication between stakeholders [31]. The more complex the physical and the social world get, the more communication is needed for its understanding and the preparation of a common ground [15]. These findings will be additionally supported by Norman’s Theory of Action [33]. On the one hand, model creators (i.e., system designers) aim to communicate their understanding by representing it within the model. On the other hand, model users (e.g., internal auditors, compliance experts, managers, or lawyers) aim to understand the modelled real world object which is represented by the model [19, 33]. Norman [33] sees the modeling process as a way to bring the system design conceptions of model creator and model viewer together.

In order to demonstrate the relevance of modeling legal requirements, we draw on existing research in the area of auditing and accountancy decision making. For example, Amer, Lucy, and Maris [3] found that ‘spatial or graphical representations prove to be the most efficient tool for auditors or programmers conducting a review of that documentation’. In particular, auditors who evaluate companies regarding their compliance with legal regulations will be supported by using structured and graphical representations of business processes and databases. Graphical representations are a powerful instrument to reduce the complexity of tasks which was already examined from a cognitive perspective [48].

Boritz [10] proved that the structure of information presentation plays a significant role in the evaluations and plans of auditors. Dunn and Gerrard [18] compared different modeling notations regarding their effectiveness and efficiency to support the decision making of auditors. These studies support the high influence of graphical representations on the decision making process in an auditing context. Thus, it can be expected that modeling techniques are a vital factor for proving legal compliance, at least for audit processes. From a theoretical point of view, the cognitive fit theory [49] underlines the importance of considering task and representation for an optimal problem solving. If there is ‘a complete fit of representation, processes, and task type, each representation will lead to a quicker and more accurate problem solving’ [49].

Tuttle and Kershaw [48] found out that graphs support holistic judgment strategies in a better way than tables do (tables support analytic judgment strategies in a better way). Therefore, it seems to be important to consider different representational forms for different circumstances, which is also valid for the representation of legal regulations. It is hard to analyze a certain law regarding the appearance of a particular word or a certain phrase. In order to analyze a law it is more feasible to consider law in its contextual environment, e.g., relationships between different paragraphs like the definition of terms or the linkage between different paragraphs.

Another important communication aspect is the consideration of media. Among other capabilities of media, symbol sets have been identified as one factor that influences the development of media synchronicity and the successful performance of communication processes’ conveyance and convergence [17]. If symbol sets are an important factor for successful communication, especially legal departments and IS departments of companies have to think about suitable means for communicating with each other and generating a common ground [15] about legal requirements on IS. According to Carnaghan [12] and Knechel [29] only little research exists about information needed for a proper business process documentation for audit risks. On a strategic level some work has been done by Bell, Marrs, Solomon and Thomas [8]. However, the requirements for information systems modeling languages that enable effective and efficient communication about legal aspects are still to be determined.

Based on a better comprehension of information systems [44] as well as a better handling of information systems’ complexity through information models [47] an essential contribution to the development and modification of compliant information systems can be expected. When system designers have to decide whether a modification of an information system is legally compliant, this decision requires either detailed knowledge of the corresponding law or a separate review and approval by an internal audit or legal department. Both ways lead to additional effort that could be reduced when legal aspects are already considered during the
modeling phase of information systems and its corresponding processes.

Additionally, considering legal aspects in information models might influence the cost aspect. When legal departments validate software by reviewing conceptual information models, the encoding and decoding effort will cause production costs and processing delay costs [42]. There would be no more need for encoding and decoding model elements when information models directly consider legal requirements (i.e. when models are developed in accordance with legal requirements). That may lead to decreasing compliance management costs.

3. Framework Based Research Agenda

3.1. Framework

The research field of information systems modeling that supports a common grounding [15] between legal experts and IT experts can be structured by using a framework which is spanned by three dimensions (Figure 1):
arrangement are defined. Those symbols are then assigned to specific language constructs.

In contrast to the OMG Metadata Architecture, which contains a model instance level, we propose the analysis of models as a third level. Model instances contain concrete data of running programs. In this state the consideration of legal requirements is hardly possible since the transactions are already running. Model analysis in general aims to identify flaws, weaknesses, and potential for improvement and tries to reveal improvement suggestions and/or corrections before the model will be instantiated, while the model is applied, and after its application. In context of conceptual modeling of legally conform information systems the model analysis aims for detecting model parts which are, e.g., not legally compliant. The model analysis is dependent on the meta model level and model level. The language which is defined on the meta model level has to provide the necessary language constructs which then can be analyzed. The models themselves have to extensively describe the facts of the relevant domain.

- **Research approach**: Research in the context of conceptual modeling of legally compliant information systems can either follow a design science or a behavioral science approach. Design science aims for the development of artifacts which provide an effective and innovative contribution to the solution of a certain problem. These artifacts can be typologies of terms, methods, models, and implementations [26]. Design science includes iterative development of suitable artefacts or classes of artefacts and the evaluation of their effectiveness [36, 39]. While design science tries to modify the existing situation by providing new instruments and solutions, behavioral science intends to describe the status quo or a prognosis for certain developments. Both research approaches are directly related to each other. Behavioral science contributes to the identification of relevant problem domains for which artifacts can be developed. Furthermore it can help to explain the effectiveness of those artifacts [5].

### 3.2. Research Agenda

The framework’s orthogonal dimensions are applicable to derive a structured research agenda for conceptual modeling of legally compliant information systems. The following research questions are related to the framework and show the potential of an integrated consideration of legal visualisation and information systems modeling:

- **On meta modeling level** and from a *behavioral science* perspective, an upcoming question could be: What integrated approaches of information systems modeling and legal visualization already exist for the consideration of legal requirements in conceptual modeling techniques for information systems? How well does a certain modeling technique satisfy the needs of legal experts? In order to evaluate this, one has to identify valid or conceivable legal regulations of a particular *domain* and analyze to what extent existing research approaches provide the necessary language constructs and representations to model them. Legal regulations can prescribe or legitimate certain features or properties of information systems. Therefore it is particularly interesting in what way legal regulations and their visualization is adopted in conceptual models of those systems. A possible outcome of this analysis could be that none or plain differences between certain domains exist, concerning the representation of corresponding legal regulations in information models. On top of the status quo analysis one has to examine what design principles of conceptual modeling are effective for the design of legally compliant information systems. The effectiveness can manifest, e.g., by an early detection of possible legal violations, cost reduction of legal analysis or an improvement of the cooperation between legal experts and IT experts. Relevant questions are, e.g., what consequences arise from missing language constructs and what increase of model complexity induced by the integration of legal regulations is still accepted in practice.

- From a *design science* perspective and on *meta modeling level* the research agenda suggests the development of new modeling and representation techniques for a common grounding between legal experts and IT experts when designing information systems in a certain *domain*. This includes the enhancement of existing modeling techniques with additional language constructs that enable on one side a comprehensive modeling of legal issues and on the other side the interdisciplinary comprehensible documentation of legal regulations that are the basis of conceptual decisions.

- **On model level** and from a *behavioral science* perspective, it has to be examined what organizations under what conditions actually use what modeling and visualization techniques for the
specification of domain-specific issues in conceptual models. Usage may, e.g., be dependent on the distribution of legal expertise and IT expertise within organizations. Competencies can be distributed on several people or in an extreme case bundled in a single person. One could further ask what impact missing or existing models have on legal compliance and cost effectiveness of information systems design in organizations. Do different types of conceptual modeling influence the communication between legal experts and IT experts? This research can be conducted for reference models or for specific models, which are customized for the respective organization.

- From a design science perspective on modeling level the research agenda proposes research on reference modeling. The design of legally compliant information systems motivates the extension of existing reference models with additional content. This extension relates on the one hand to the modeling of structures and properties of information systems in a certain domain under certain conditions. Configurative reference modeling (for the different types of supporting reference model application cf. [7, 16]) enables the creation of context-dependent model variants by defining configuration terms. In this way, one could, e.g., figure out consequences for information systems design that result from differing state law. On the other hand a reference model should consider that certain structures and properties are based on legal regulations. References to legal regulations or their representation can prevent the user of a reference model from customizing the model in a non-compliant way. This naturally requires a comprehensible presentation of the relevant legal references.

- On model analysis level and from a behavioral science perspective, one can examine extent and purpose of using conceptual models to ensure legal compliance in organizations. This implies the identification of essential analysis requirements for conceptual specifications in certain domains. Relevant question are, e.g.: What parts of information systems are potentially affected by changes of law? Does model analysis help system designers and legal experts to identify legal violations and compliance risks? At which stage of information system design is a legal assessment usually conducted? Conceptual and legal specifications could be, e.g., analyzed exclusively prior to the implementation phase. Or they are continuously analyzed in order to prevent non-compliant behavior. The value for an organization has to be examined depending on these different types of analysis. An essential factor for the analysis’ value is the degree of automation.

- Research from a design science perspective on model analysis level can provide new approaches for model-based assurance of legally compliant concepts. A model editor can, e.g., incorporate an evaluation module that can analyze the model repository and detect those model parts that are linked with certain legal regulations. Advanced scenarios of automated model analysis base on pattern matching. A pattern thereby consists of legal rules for certain domains that are stored in a rule database. It is then possible to match a model against this database and make the modeler aware of possible legal violations.

### 4. Exemplary Application of the Framework-Based Research Agenda

The presented framework can be used to either classify existing research or to derive future research questions in the area of conceptual modeling of legally compliant information systems modeling. In the following, some exemplary research results are presented, that are classified with the research framework. For each work we show exemplarily how the research framework can be used to derive new research questions or topics (Figure 2).

Goeken and Knackstedt [20] extended the modeling technique Multidimensional Entity/Relationship Model (ME/RM) to include reference model elements for the conceptual modeling of reporting obligations for investment service companies (see Figure 3). The model consists of three dimensions and six ratios that are necessary to implement reporting regulations of the European markets in financial instruments directive (MiFID). It is argued that reference model elements (like Build-Time-Operators) are necessary to represent data warehouse models for the fulfillment of the MiFID, which provides rules for the harmonization of European investment services. Furthermore a conceptual model of a part of MiFID regulations, based on the extended ME/RM approach was presented [20]. The positioning in the legal informatics research framework is twofold. The approach can be classified as a meta model (A1) as well as a concrete model (A2) within the domain ‘Reporting’. Considering the extended ME/RM modeling technique it seems reasonable to structurally implement this modeling technique and
the MiFID model into a modeling tool for enabling model analyses. In this way, questions like ‘Which data warehouse elements are affected by a certain regulation change?’ or ‘Which regulations are affected when a data warehouse element should be changed?’ could be answered (A3). From a global perspective these questions lead to an investigation of the effectiveness and efficiency of reporting model analysis when supporting internal audit and legal departments (A4).

To formally model and visualize legally regulated processes in the area of e-government, Olbrich and Alpar [34] presented a formal approach based on the Semantic Process Language (SPL). They show how to derive a process structure directly from the legal paragraphs themselves and how to transfer this structure into an executable workflow model. The demonstrated model is based on the obligation right of Switzerland. Since the paper presents a new legally based process model the research result can be classified as a model in the domain ‘process compliance’ (B1). In further research projects it is imaginable to ask for the efficiency and effectiveness of such models. Two questions that might be part of further research could be: Will formally derived legal process models lead to more compliance? If they have positive effects, are they also more efficient? (B2).

Becker et al. [6] made a legally based contribution in order to reduce the complexity of compliance checking of process models by partially automated model checking. In addition their generic pattern matching approach was applied to the Semantic Business Process Modeling Language (SBPML) allowing the checking of process models which is not restricted to predecessor-successor relationships. Finally, a concrete credit approval process from a real-world bank scenario was used to demonstrate the applicability of the developed model analysis approach. The approach can be classified as a research contribution in the domain of ‘process compliance’ on ‘model analysis’ level (C1). The application and evaluation of the method in different application scenarios with different kinds of compliance rules is still an open research task (C2). Field C3 exemplarily asks for the effectiveness of model analysis methods (e.g., in comparison to [21, 22, 40]) in supporting business process compliance management. Another interesting research question within field C3 could be: Are pattern matching approaches an appropriate means to decrease the effort of legal departments to detect compliance violations in the banking industry?

Knackstedt et al. [27] identified four major modeling approaches for web applications, namely Araneus, eW3DT, WebML and OO-H. At the same time current law was analyzed in order to identify relevant legal regulations concerning the design of web applications. The selected modeling approaches were subsequently examined regarding their ability to model these regulations. This work therefore contributes to behavioural science research on meta model level in the domain ‘Web-Applications’ (D1). Further, the modeling approach eW3DT is adapted. The language based meta model of eW3DT is reconstructed and afterwards extended with additional language constructs that are capable of representing the mentioned legal regulations including suggestions for the representation form of these constructs. This conceptual and representational adaption is a design science contribution on meta model level (D2). Future research on this topic could address reference models for web applications [55]. The introduced language extensions could be used to
extend reference models with legal issues, e.g., that certain web pages are mandatory or prohibited. This would be a contribution to design science research on model level (D3).

The above mentioned questions are just a small selection to a research field that has not the attention that it should have in our opinion. From a design science as well as from a behavioral science perspective, a lot of interesting research work is left for IS researchers. With the help of the research framework for legal information systems modeling it is possible to categorize existing research results and to find research gaps.

5. Conclusion

We proposed a framework for an integrated research approach of information systems modeling and legal requirements. The framework consists of three dimensions: ‘domain’, ‘model level’ and ‘research approach’. Based on this framework we derived a research agenda for conceptual modeling of legally compliant information systems. To examine the impact of law on the design of information systems and on conceptual modeling of information systems is a relevant subject when considering organizational aspects of information systems. Facing the relevance of information systems modeling for the design of compliant information systems the proposed framework has several benefits for researchers:

- It allows researchers for positioning own work in the respective research area and can help researchers to derive new research questions. Although we only examined an exemplary selection of research work, it appears that most research in the field of conceptual modeling of legally compliant information systems follows a design science approach. Our hypothesis is that there is a lack of behavioral research in this field. However, this hypothesis has to be tested by a comprehensive and rigorous literature review. The proposed framework can be used to systematically conduct such a literature review and to conceptualize the results. The occurrence of
research results of such a literature review in the respective framework cells could be used as a measure to identify those fields where research is most needed.

- The framework can be used to get an overview about the respective research field and the relevant dimensions. Therefore it can be utilized for the creation of online research portals or online research maps like in Knackstedt et al. [28].
- It can provide a basis for a study among practitioners where they are asked for the relevance they see for research results in each of the framework cells. This could be a measure for practical demand of research in the different fields.

6. References