Enterprise Modeling for Respecting Regulations

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Abstract. The paper reports on experience in creating an enterprise model compliant with the Latvian Accounting Law. The focus is on a possibility to represent parts of the law in the form of business processes. The issues that the law considers together with the information on processes are organized in related sub-models. The main elements of the enterprise model sufficient for representing issues prescribed by the regulations are presented and discussed. The suitability of the de facto business process modeling standard BPMN 2.0 for representing regulations is examined.

Keywords: business process, compliance, BPMN, enterprise modeling

1 Introduction

Different types of regulations [1] are to be taken into consideration when organizing enterprise business processes. At a high level of abstraction regulations can be divided into the following categories [2]: mandatory regulations, which are issued by governing bodies; "good to have" non-mandatory regulations such as various industry standards; and internal regulations, which are chosen by an enterprise to be followed in its performance. From the enterprise point of view, the first two types of regulations are regarded as external regulations. Internal regulation may depend on (or mirror) external regulations as well as they may be independent.

In the scope of this paper we are examining and analyzing only external regulations that are mandatory for enterprises. The purpose of the research is to represent the law as parts of business process model that can be used by enterprises in designing and managing their business processes [2]. Using the law mirroring parts of business process models would prevent enterprises from multiple efforts of translating regulations into business processes. It is also necessary to maintain the business process linkage to the specific structural parts of the regulation to ensure regulation change monitoring and thus facilitate up-to-date business process compliance with the regulations.

The goal of the paper is to contribute towards the enterprise modeling method that would provide enterprises with business process patterns, which precisely and completely conform with valid external (issued outside the enterprise) regulations. For achieving this goal we have analyzed the relevance of currently popular process modeling language - Business Process Model and Notation (BPMN) – for modeling

of external regulations. BPMN is the standard for representing in a very expressive graphical way the processes occurring in virtually every kind of organization [5]. Moreover, it is the de facto business process modeling standard [5] and currently is implemented by more than 70 applications [3]. According to [4] BPMN is a plenty construct-rich process modeling language that could be successfully adopted for modeling of procedural aspects of regulations. In the scope of this paper we attempt to verify how BPMN 2.0 language constructs overlap the core elements of regulations based on the developed meta-model of regulations. The comparison is empirically approved by the case study creating an enterprise model process patterns for the Latvian Accounting Law. Based on the obtained results, we can conclude that BPMN 2.0 cannot fully support modeling of regulations, because of its limitation concerning structural modeling. For modeling of regulations in full extent, it is necessary to represent not only the procedural nature of regulations, but also the constraints on data content, organizational structure, information systems functionality, etc.

In this paper we envision a solution which is based on the set of inter-related models each focusing on a specific aspect of regulations: processes, data, organizational structure, events, information systems, and rules. A collection of these models is sufficiently complete to describe the regulations in useful way. Proposed approach is similar to enterprise architecture modeling approaches, as it also captures the structure and dynamics of an enterprise as collection of multi-level and inter-related artifacts, i.e., diagrams, documents, and models [6]. We provide the comparison of proposed approach with enterprise modeling method EKD (Enterprise Knowledge Development) [7] that is a representative of the Scandinavian strand of enterprise modeling methods. We have found considerable similarities between EKD and our approach; hence this enterprise modeling method has been selected for comparative evaluation.

The remainder of the paper is organized as follows. In Section 2 related work is outlined. In Section 3 core elements of the regulations are presented and compared to meta-model of BPMN 2.0. In Section 4 the empirically faced limitations of BPMN 2.0 are illustrated. Section 5 contains the enterprise model proposed for regulations modeling and its comparison to the enterprise model used in well-known EKD method. Brief conclusions are presented in Section 6.

2 Outline of Related Works

In [9] authors provide a high-level architecture of the document analysis and change detection system which is used for the retrieval of regulations and document analysis and preparation for their linkage to business processes. Another related field is legal informatics which addresses the linkage between business process models and legal documents in order to create traceable law models [10]. The Legal Knowledge Interchange Format (LKIF) is a semantic web based language for representing legal knowledge in order to support modeling of legal domains and to facilitate interchange between legal knowledge based systems [11].

The more recent approaches towards achieving compliance strive to provide some level of automation through automated detection. For instance, in [12] proposed an

approach that has a preventative focus. At first, the approach allows a formal representation of control objectives in formal language for representation of compliance requirements (using FCL-Formal Contract Language). Then, control tags should be defined from FLC expressions, and used to visually annotate and analyze typical graph based process models. However, it remains unclear, how to linkage process model with the source of controls to be able to detect changes in controls timely. As well as, the effect of controls is analyzed only form the process perspective, leaving other aspects of enterprise (e.g., data model, organizational model, information systems model, events model) unattended.

ArchiMate standard [13] provides a graphical language for the representation of enterprise architectures. However, the current ArchiMate 2.0 specification does not address business policies and rules concepts modeling. Very often business rules and policies are based on legislation and regulations. Because of this limitation to address business rules and policies ArchiMate 2.0 is not used as a basis in this research.

In this paper we focus only on the regulation based view on the enterprise, i.e., we examine what enterprise architecture (model) and what capabilities of business process modeling language are needed if we represent the regulation in a form of enterprise/business process models.

3 Core Elements of Regulations

In [1] regulations are defined as directives published by a legislature. Compliance of business process models to these directives is mandatory. In this paper we use softer interpretation of term "regulation". We consider regulation as a directive or guidelines that are mandatory for or chosen to be followed by an enterprise. This complies with the definition of a regulation given in [8]. The certain part of regulation may be related to the particular business process model part that represents the regulation in terms of business processes. For process modeling the candidate is BPMN 2.0 modeling language as it was recognized the most appropriate for compliance modeling [4]. Visualizing the content of regulations, we may obtain the business process patterns that may be made publicly available for the enterprises. It is necessary to provide mappings between core elements of regulations and corresponding elements of process modeling language to have a linkage between the regulations and their visualization. For this purpose we provide the meta-model of core elements of regulations (see Figure 1). The core elements of regulations were obtained empirically from modeling the Latvian Accounting Law [13] and are built to conform to Bunge, Wand and Weber ontology [14] concepts that define the things to consider when developing information systems. The developed meta-model of regulations is compared with simplified BPMN 2.0 meta-model (see Figure 2) which is based on the standard specification of BPMN 2.0 [3]. Simplified BPMN 2.0 meta-model consists of only those elements that could be useful for representation of regulations. The results of comparison are summarized in Table 1. They reveal that BPMN 2.0 has several limitations if considered as a business process modeling language for modeling regulations. Some empirical illustrations of these limitations are provided in the next section.

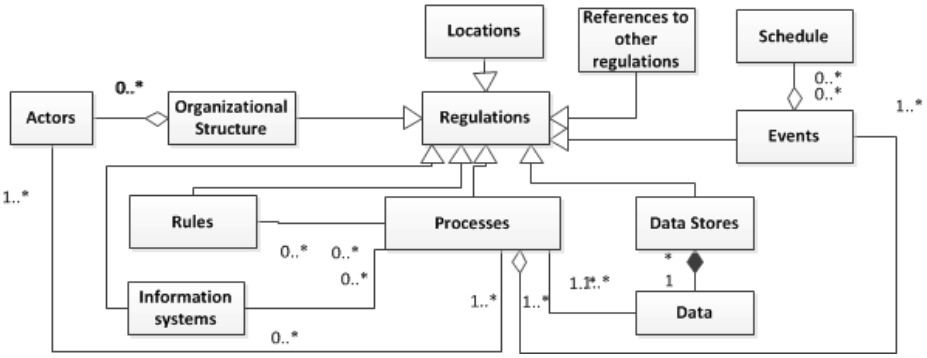


Fig.1. Meta-model of core elements of regulations

Table 1. Comparison of core elements of regulations with BPMN 2.0

Regulation elements	Description	BPMN elements
Processes	The sequence of activities required to be performed to comply with the law	Activity, Control Flow, Gateway
Events	Something that happens at a given place and time	Events (is not possible to specify user-defined events)
Schedule	Dates and times at which things are required to occur	Not supported (does not show the events ordered according time axis)
Actors	Roles that are required to take part in specific processes	Pool, Lane (does not allow to model inter-relationships between actors, and their authorities and permissions)
Organizational structure	Organizational entities that are required to take part in specific processes	Pools, Lanes (does not allow to model inter-relationships between organizational entities)
Data	Collections of facts processed during activities as inputs or outputs	Data Object, Message (does not allow to model inter-relationships between data objects and attributes of objects)
Data stores	Registries for storing and accessing data	Data Store (does not allow to model the content of data store, data visibility and access permissions)
Information systems	Software applications that assist a human performer to carry out an activity	Pool, Lane (does not allow to model the functionality of information systems and inter-relationships between them)
Rules	Definitions, operations, constraints and statements that resolve either true or false	Business Rule Task (is not possible to show the internal structure of regulation and links with other regulations)
Locations	Geographical and spatial locations of the enterprise, data stores, and information systems	Not supported
References to other regulations	References to linked and derived regulations	Not supported

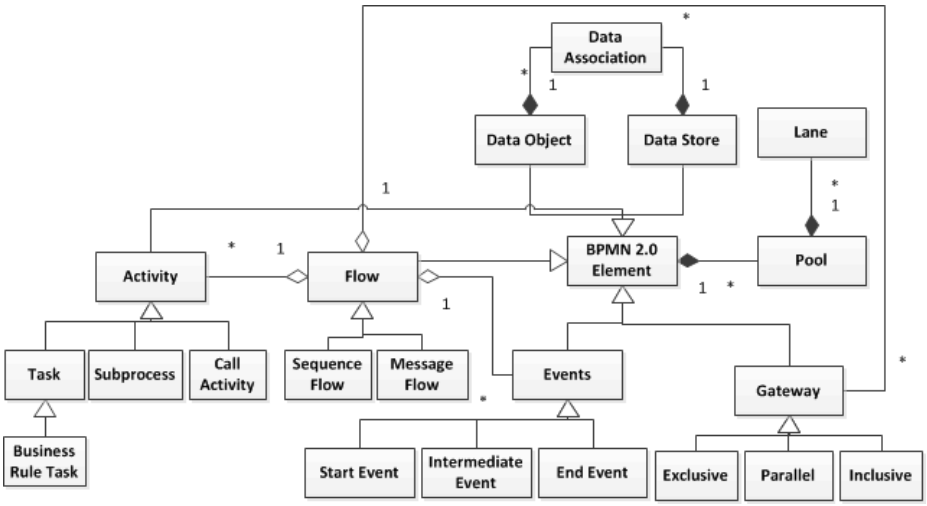


Fig.2. BPMN 2.0 simplified meta-model

4 Limitations of BPMN 2.0

Limitations of BPMN 2.0 detected in the previous section were verified empirically by carrying out the controlled experiment in the project where the Latvian Accounting Law [15] was modeled. The following BPMN 2.0 limitations were identified:

1) BPMN 2.0 does not support data structure modeling apart from process model. In the context of regulation modeling, thus it is not possible to specify constrains on the content, visibility, and access permissions of data objects. For example, in Figure 3 the fragment of governmental regulations that sets the inventory procedure is shown. In the business process model the sequence of inventory activities is represented, but constrains on the content of the source documents are not supported (see Rule 1).

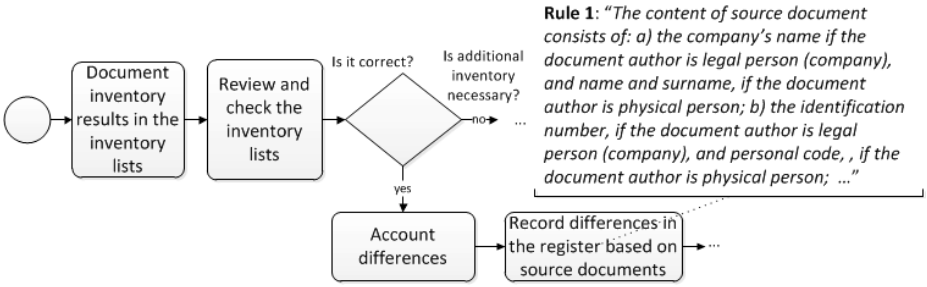
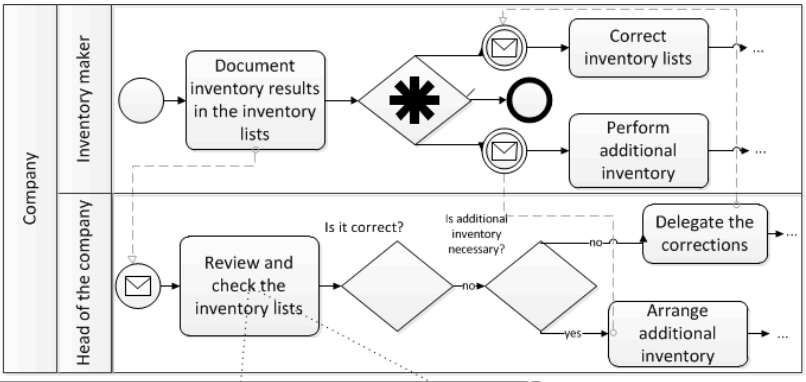


Fig.3. Missing regulations on data structure

Regulations prescribe permissions, authority, obligations, and competencies of actors that perform the activities. Currently the inclusion of organizational perspective in BPMN 2.0 is limited, i.e., actors and organizational units could be modeled in pools

and lines without additional information. For example (see Figure 4) Rule 2 specifies the generalization of class "head of the company", including all possible sub-classes. And Rule 3 defines the responsibilities of the role "Head of the Company". This information is not included in the model.



Rule 2: *"Head of the company is: a) all members of the community in the case of partnership; b) the board of the administration in the case of the capital organization; c) the board of the administration or person who fulfills its functions in the case of the cooperative society; ...".*

Rule 3: *"The head of the company is responsible for the losses committed to the company, the state or to a third party, that resulted from violation of the law".*

Fig.4. Missing regulations on organizational structure

2) BPMN 2.0 provides modeling primitives for standard event types, e.g. Message, Signal, Start, and End, but this is not enough in the case of regulation documentation. The main mission of offered event types is modeling of executed processes. However, it should be possible to specify user-defined pre- and post-conditions, in order to force the analyst to model the activities as lawful sequence of events and state changes of the data objects. For example, see Rule 4 in the Figure 5 where the first activity of accounting process may start only if certain pre-conditions are fulfilled. There are two possibilities how to model this regulation with BPMN 2.0 language.
   - We can use *Parallel Multiple Event* object that indicates multiple ways of triggering the process or activity [3] as it is shown in the Figure 5. It means that multiple activities or events are enabled in parallel, and have the potential to occur at the same time. This could be appropriate language construct for modeling pre-condition, but unfortunately this may lead to misunderstandings. Event objects denote starting point of activity execution, i.e., when activity should be started. But we should model just pre-conditions of activity not the triggering conditions.
   - The language construct appropriate for modeling pre- and post-conditions is *Parallel Event-Based Gateway*, where the occurrence of all subsequent events starts a new process instance. But this language construct is used to denote several inclusive or exclusive paths of process execution. That means it is not possible to model conditions that should be fulfilled in parallel. Other limitation is that *Event-Based Gateways* are configured by having outgoing *Sequence Flows* target an *Intermediate Event* or a *Receive Task* in any combination [3].

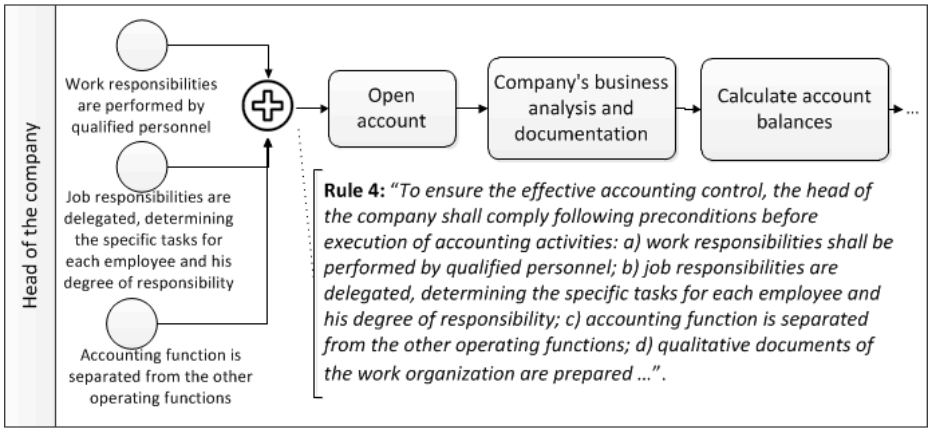


Fig.5. Using Parallel Multiple Event object for modeling regulations on pre-conditions

3) BPMN 2.0 does not allow to model constrains on information systems, registers, warehouses and their geographical location in full extant. Using Data Store object it is possible to model information that is retrieved or updated in the data stores (see Figure 6), but modeling constructs that could be used for inclusion of information systems (software applications) in process model are missed. In addition it is not possible to represent the content of data store that is prescribed by the regulations. For instance (see Figure 6), Rule 5 specifies how long the documents in archives should be saved, while Rule 6 constrains the language that should be used in the registers. As well it is not possible to represent the mandatory functions of software application that should be used to perform certain activity or general set of functions that should mandatory provide the software application. For instance, Rule 7 specifies that the accounting software program must provide certain functionality and data formats (see Figure 7).

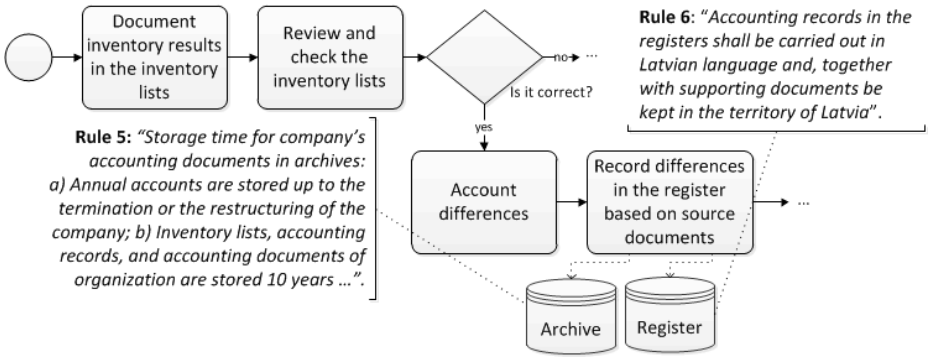


Fig.6. Missing regulations on data bases

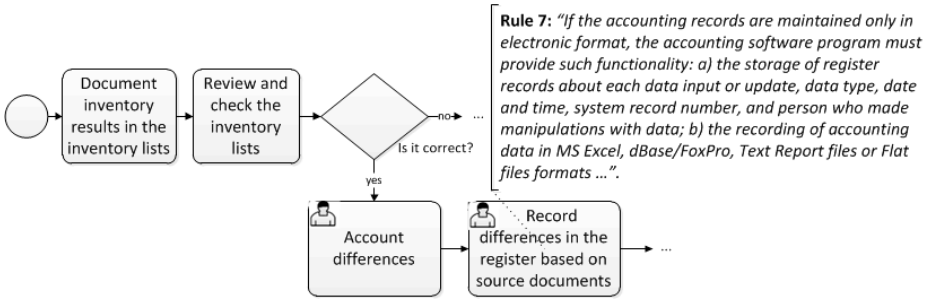


Fig.7. Missing regulations on information systems

4) Regulations describe dates and times at which things are required to occur, thus modeling language should provide representation of the time/dates. BPMN 2.0 includes special type of event *Timer* that could be used for this purpose, but, in addition, it may be preferable to obtain separate diagram with events ordered according time axis similar to Gantt chart. For example (see Figure 8), Rule 7 constrains the starting data of accounting period, but Rule 8 specifies the lawful duration of this period.

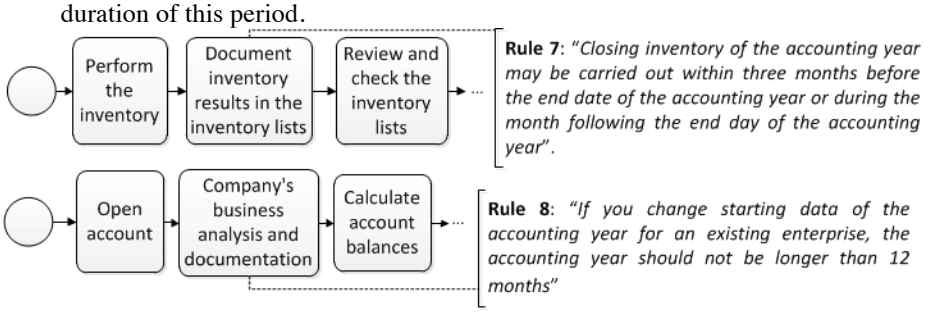


Fig.8. Missing regulations on time/dates

5) Ordinary the process model expresses actions that should be carried out, but on the other hand regulations may describe illegal actions that are not allowed to perform. None of process modeling languages (including BPMN 2.0) directly provides such a possibility.

5 Inter-related enterprise models for capturing of regulations

In this section we describe the proposed architecture (enterprise model) for regulations modeling. For complete and precise modeling of regulations it should be provided the parallel development of several sub-models using inter-model links. The ability to trace fulfillment of regulations throughout the enterprise is dependent on the use and understanding of these inter-model relationships. Each of these sub-models emphasizes the certain aspect of the regulations according to the particular enterprise architecture artifacts. We distinguish the six sub-models:

- *Regulations Model* that defines and maintains explicitly formulated rules, consistent with the source documents such us governmental law and

corresponding to them regulations. On the one hand, this model helps to deal with conceptual linkages within one regulation and across several regulations, as well as with their legal hierarchy. On the other hand, it clarifies the linkages between the organization's structure, performed business processes, used information systems, and processed data artifacts;

- *Business Process Model* that defines enterprise processes that are constrained by regulations, the way they interact and the way they handle information as well as material. Business Process Model clarifies, which activities the organization should perform to manage the organization in compliance with regulations;
- *Organizational Model* that describes how different actors and organizational units should be related to each other and what permissions and obligations they have corresponding to the regulations;
- *Data Model* is used to strictly define the "things" and "phenomena" described in the regulations. Data Model represents enterprise concepts, attributes, and relationships as well as what rules and constraints that monitor these objects and concepts;
- *Information Systems Model* where attention is focused on the technical systems that are needed to support the business processes of the enterprise. This model clarifies questions, such as: what are constrains on the information system to be used, which functionality information system should perform, with what other systems it should be integrated, what data formats are mandatory, etc.;
- *Events Model* that provides a convenient way to explicate time relationships between people, places and actions, i.e., Event Model defines events ordered according time axis, activities triggered by events, geographical location and involved actors.

The modeling elements of the sub-models are related between themselves within a sub-model *(intra-model relationships)*, as well as with components of other sub-models *(inter-model relationships)*. Figure 9 shows *inter-model relationships*. The ability to trace regulations throughout the enterprise is dependent on the use and understanding of these relationships. The central role plays two sub-models, namely, Regulations Model and Business Process Model. All other sub-models are associated with these two models. For instance, the structural relationships between performers of activities in Process Model are clearly defined in Organizational Model. In the same way, temporal and spatial relationships between events and activities in Process Model are particularly specified in Events Model. In addition each sub-model have links with Regulations Model to clarify which parts of the regulation correspond to which part of the business process, data, organization, information systems or events. Links between the sub-models make the model traceable.

To manage rules which are included in Regulations Model and still keep the linkage to their original source, one more link (*external relationship)* is required. External regulations issued by the government usually are available in the web pages of the governmental institutions. There are also web portals providing search facilities of the regulations by such criteria as issuer, type, subject, free text search and other criteria. Therefore we propose solution that has been developed in our

previous researches [9]. The main idea is to identify and annotate document structural elements that could be referenced with *external relationship* by element of Regulations Model using direct URL's (see dashed line in Figure 9). Thus we gain the ability to reference specific part of the document (title, chapter, section, article, sub-article), that should be directly applied when implementing business process. This link between the rules of Regulations Model and their original source is captured by the elements in other sub-models via *inter-model relationships* (see bold lines in Figure 9).

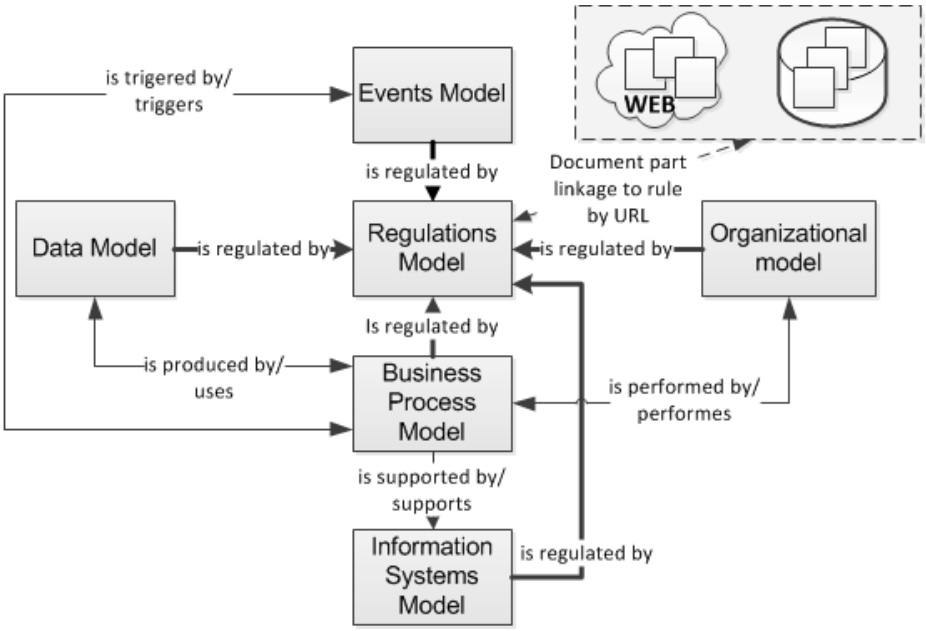


Fig.9. Regulation modeling using the inter-related models

The proposed approach is verified according the enterprise modeling method – EKD [16], that is Scandinavian strand of enterprise modeling methods. Figure 10 on the right (see B) represents the EKD sub-models with their inter-relationships, and on the left – the proposed sub-models with appropriate links.

There are obvious similarities between Data Model and Organizational Model of proposed approach and corresponding models in EKD (Concepts Model and Actors and Resource Model). These models have the same focus and modeling primitives for representation of structural relationships between elements (e.g., generalization, composition, specialization). Moreover, the meaning of Business Process Model in EKD is very close to the model proposed in our approach. Differences are related to the syntaxes and quantity of used modeling primitives, because BPMN provides more expressive notation than EKD Business Process Model. Information System Model in our approach differs from the Technical Component & Requirements Model in EKD as in our case this model specifies constrains on the functionality of information systems, but in EKD it specifies the needs (requirements) of information systems. We have proposed the new model, namely Event Model, instead of Goal

Model in EKD. This model portraits constrains on the events and timing. Relationships between sub-models are different, too; because in our approach the emphasis is on structural and behavioral aspects of regulations, where the most important are Process Model and Regulations Model. In EKD there are more inter-model relationships, as the main purpose is to capture as much knowledge about enterprise as possible.

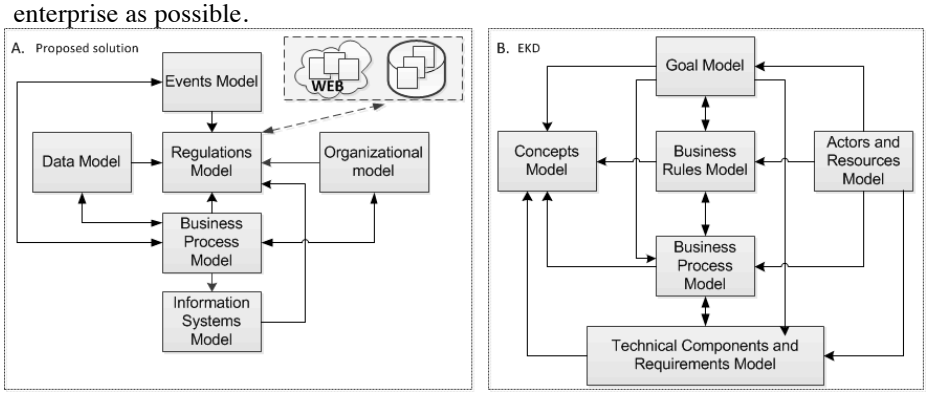


Fig.10. Comparison to the enterprise model used in EKD: A. inter-related set of proposed models for modeling of regulation; B: EKD inter-related models [7].

6 Conclusions

The paper reports on enterprise modeling experiment that is based on representation of regulations as reusable business process model parts. The experiment showed that for proper positioning of the parts it is necessary to represent in models not only the process per se, but also other related information available in regulations. The paper proposes the enterprise model suitable for modeling regulation. The comparison of this model to a well known enterprise model helps to see that the enterprise model has to include an events model as one of its sub-models for regulations modeling purposes.

The paper contributes with clearly described and illustrated limitations of BPMN 2.0 in its applicability for regulations modeling. It is a matter of future research to overcome these limitations, since due its popularity the BPMN is still the main candidate for modeling regulations in situations where models are developed for public use.

The research experiment described in this paper is limited to one law and its related regulations only. Further experiments with other regulations may reveal some new requirements for enterprise and process models. The general aim of the research is to provide reusable business process model parts (that mirror regulations) in cloud [2] in order to enable easier enterprise business process compliance to regulations.

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