A Framework for Translating Legal Knowledge into Administrative Processes: Dynamic Adaption of Business Processes

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Abstract. Adapting to and complying with frequently changing legislation quickly against low costs requires organizations to adapt their business processes automatically. Semantic representation of legal knowledge is a prerequisite for the automatic creation of business processes. Business Rules (BR) can be used to capture legal knowledge and business processes can be created by selecting, composing and invoking Semantic Web Services (SWS). In this paper, a modeling framework is presented that enables the automatic creation of business process by invoking SWSs. Process creation is conducted by BRs derived from legislation. The framework addresses the modeling of legal knowledge representation and service descriptions that are required for creating operational processes at runtime. The framework is briefly illustrated by a legislation implementation case study which shows how compliance between business processes and legislation is ensured.

Keywords: Business process management · Business rule · Semantic Web Service · Legal knowledge representation · Administrative organization

1 Introduction

Legislation is formulated as law, regulations or guidelines that need to be implemented by administrative organizations. Legislation typically changes frequently and these changes need to be adopted by administrative organizations. This often demands changes in business processes supported by software applications. As such there is a need for business process management (BPM) systems that are able to adapt to these changes against low costs and within a short time frame. This is complicated as multiple sources of legislation often need to be included and processes might vary based on specific circumstances.

Building and maintaining long-living processes for delivering services that can easily adopt to changes is a challenge [1]. In the effort of achieving higher process flexibility, Semantic Web Service and Business Rule technologies can be used. Business rules can be used to capture legal knowledge and business processes can be created by selecting services and composing them in a sequence.

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Semantic Web Services (SWSs) are an emerging approach for designing an architecture that would provide flexible integration and adaptability to changes in the processes [2]. The advantage of using SWSs is that semantically described services (which are human and computer readable) can be composed into complex processes corresponding to the needs of a service request. By using their semantic descriptions, services can be automatically selected based on their functionality, input set, output set and composed into a process (see for example [3]).

A *Business Rule* (BR) is a directive intended to influence or guide business process behavior [4]. Although there is no unified classification of rules, BRs can be generally categorized into declarative rules which define the goal of an operation, and operative rules which describe how an operation should be done [5]. The forms or formats of business rules are various depending on the technologies in use.

There has been much work in which BRs are used to create business processes. For example, BRs can be used to determine how a Web service composition should be structured and scheduled [6], or realize dynamic service composition [7]. Yet business processes in administrative organizations have to comply with legislation, which is hardly given attention in research. Current approaches in a governmental context largely focus on operational processes or knowledge representation of laws without considering its possible use in the creation of business processes [1]. There is limited research into how business rules can be used by administrative organizations to describe their legal knowledge and to use them to create business processes.

Administrative organizations take legislation as input, interpret it and implement it in their operational processes. Translating legislation into BRs is done by deriving the rules from multiple sources rather than just from legislation. According to Goedertier and Vantienen [8], other sources include the business strategy, internal directives, procedures, information prerequisites: the information required to start an activity, and technical and common-sense constraints.

In this paper, we propose a framework which is able to derive business processes from legal knowledge described by BRs. Our framework integrates SWS and BR technology to create administrative processes automatically. Both Web services and BRs are used to execute processes. BRs that are derived from legislation and those derived from other sources are clearly separated to allow the traceability between legislation and BRs. During process execution, Web services are invoked according to their semantic description and related BRs. A domain ontology that provides unified vocabulary and taxonomy is used to provide interoperability between SWSs and BRs. This framework is not an all-in-one solution or type of technology, instead, a reference framework is developed which allows various technologies to fulfill their roles at different levels.

2 Challenges in Implementing Legislations

When adapting to changes in legislation the first step is to let legal experts analyze the text of legislation and interpret them with necessary extra information. Then IT personnel build BRs models according to their interpretation using certain knowledge representation techniques (e.g. semantic network [9]). Finally, these BRs are deployed

into a BR engine and tested. At runtime, the engine is used in business processes for making decisions. Although this process looks easy, it is complicated as there are often multiple sources of legislation which might not be consistent and have different demands. Our framework is aimed at managing BRs at all levels to maintain the consistency and separate legislation-derived and non-legislation-derived BRs. Such a framework should provide a clear implementation of legislation which allows an easy maintenance of legal compliance of the business processes.

3 A Framework for Automatic Creation of Processes

BRs can be derived from different sources and can be represented in different forms. The essence of BRs is that they determine the behavior of processes. The core concept in BRs is the "*separation of concerns*" [10]. Current BR approaches allow the separation of "*knowledge*" (the business logic used by a decision making task) and "*process*" (the sequence of all tasks). The consideration of this separation is that in many knowledge-intensive organizations, large sets of rules are involved. Rules may change frequently and should be separated from the applications which execute them. In a service-oriented system, the "separation of concerns" can be further explained as the separation of not just process flow and knowledge but also of "*resource*" [11]. The notion of resource can be considered as an component of a software application that needs to be used or addressed [12]. In a service-oriented system, services can be invoked from anywhere and managed independently. This allows the encapsulating of all forms of resources (provided by either humans or computers) into Web Services, uses Semantic Web technology to describe them and compose them into a process by a BPM engine.

BRs that have different sources can also be clearly separated by locating them into different services to ensure a high level of reuse. Taylor and Raden [13] used the term "*decision service*" to describe a self-contained callable component with a view of all conditions and actions that need to be considered in making an operational business decision. To execute decision services supportive services are needed which can include infrastructural services like identification, information retrieval, storing etc.

An overview of the framework is given in Fig. 1. In our framework, there are three knowledge repositories: domain ontology, SWS description and BR models. A *domain ontology* has been indicated as necessary for interoperability. A domain ontology refers to the knowledge elements that comprise the conceptualization of the domain where the architecture is going to be applied [14]. A domain ontology shared by all the components enables communication and avoids conflicts and mismatching of concepts. It provides vocabulary and taxonomy (or concept hierarchy) to facilitate communication between BR models and SWS descriptions. The vocabulary provided by the domain ontology can be and should be used by the description of BRs and SWSs.

SWS descriptions semantically describe Web services. Dietze et al. [15] claimed that "a SWS description is formally represented within a particular ontology that complies with a certain SWS reference model such as OWL-S or WSMO" (p. 248).

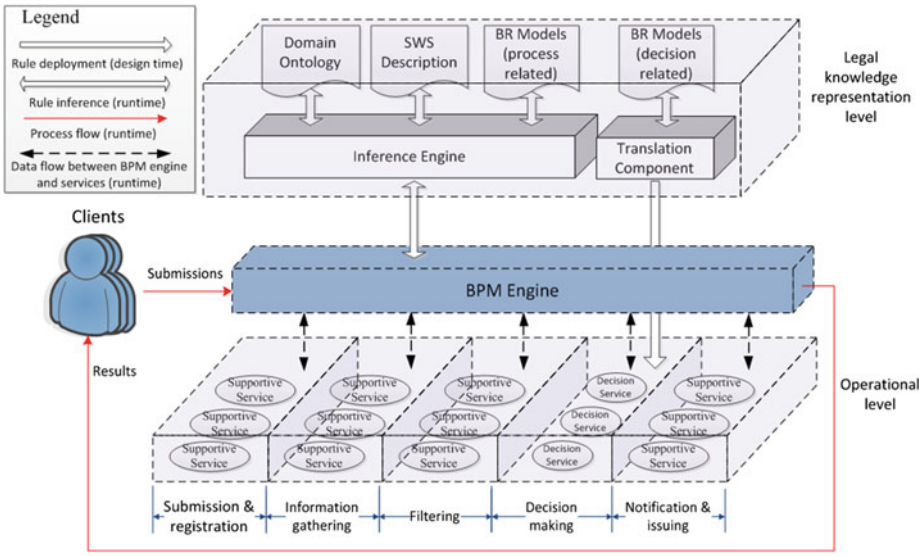

Fig. 1. A framework for automatic creation of administrative processes

Such a description is suitable for both service supply and request. All relevant aspects of a Web service should be described including the distinguishing of a decision service or a supportive service. The use of SWS description separates the management of resources.

BR models are the semantic presentation of BRs. In our framework we focus on two kinds of BRs. The first one is operational rules which are used in the decision making and which are involved in the execution of decision services. The other one is declarative rules which describe the process logic, e.g. what decision service should be select for a certain type of clients. Both these two kinds of BRs are derived from legislation and should maintain traceability and compliance with the legislation. Distinguishing decision and process related BRs enables the separation of process flows and knowledge.

For the BRs that are encapsulated in Web services, a translation component is useful for the construction of the Web services by, e.g. generating codes to assist their development.

The above mentioned knowledge entities should be presented in proper formats that allow an inference engine to perform reasoning operations on them. The inference engine uses the knowledge presented with semantic technologies and BRs to generate service invocation prescription that can be executed by the BPM engine. In our framework we use a common process pattern in this domain [16] to form operational processes. By making use of this pattern, the goal of each task in the process is clear for the BPM engine. The creation of a certain process is done by selecting proper decision or supportive services for each task and composing them, in this way creating a process. The selection of supportive services is based on their semantic descriptions,

whereas the selection of decision services is controlled by process related BRs. During the creation of processes, the inference engine works out the service selection and create a temporary invocation prescription for each task. Given the prescription, the BPM engine is able to invoke proper services in each task. The process creation is dynamic as it does not require a fully pre-defined process model. Instead, the process is created and executed step after step. Adaption in legal knowledge representation will be automatically reflected in the creation of operational processes.

4 Illustration

We use an implementation of the Highly Skilled Migrant (HSM) policy in the Netherlands to illustrate how the framework creates operational processes. According to the HSM legislation for 2012, non-EU foreigners are granted resident permits if they have an annual income no less than €37575 (applicant younger than 30) or €51239 (from the age of 30). But for persons who graduated in the Netherlands and who graduate from top foreign universities with master or PhD degree (under Highly Educated Migrant Schema[1]), the annual income requirement is €26931. To implement this legislation using the proposed framework, we performed the following steps: (1) building a domain ontology, (2) defining business services, (3) defining business rules and (4) testing process creation.

In our approach, the first step is to define a domain ontology to provide consistent understanding of concepts. In Fig. 2 most concepts used in service description and business rules are involved and connected. For space reason, we could not include every detail and its intention is only to demonstrate the structure of a domain ontology. For the business processes in a typical case handling system, the domain ontology contains the identification of different clients under the *Person* class. Similar to the Object-Oriented programming, its subclasses inherit all its properties. We also defined an Action concept, and its several subclasses with different semantic meanings.

To create processes for serving different types of clients, the immigrant office can create three decision services: one for regular HSM applicants (DS01), one for local graduate applicants (DS02), and one for highly educated migrates (DS03). Supportive services that provide income information (SS02) and diploma checking (SS03, 04) are needed to gather information for the related decision service. A supportive service for filtering is also needed for risk control, e.g. blacklist checking (SS05). For all kinds of processes, supportive services for submission intake (SS01) and returning result of decision (SS06) are required. The system then creates operational processes to provide services for applicants according to their situations: being a regular applicant or Dutch graduate or foreign graduate.

Process related BRs describe which decision service should be invoked by the BPM engine to deal the submission that they are processing. As the functions of

[1] Policy and criteria of Highly Skilled Migrant and Highly Educate Migrant can be found at www.ind.nl

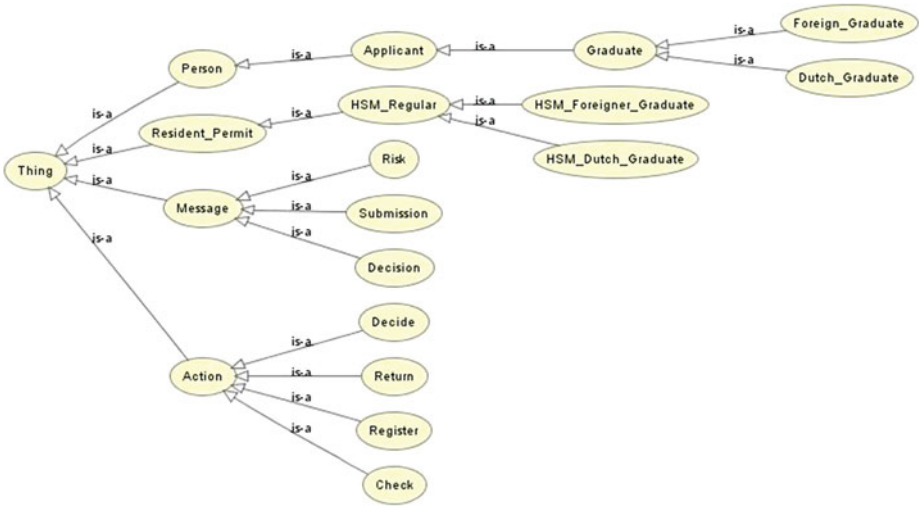

Fig. 2. Illustrative domain ontology (created using Protégé)

decision services have been semantically described, the BRs should indicate which decision service can be used for which kind of immigrant applications. We use the following RIF-core [17] rules for giving an example.

```
Prefix(act <http://example.com/action#>)
Prefix(per <http://example.com/person#>)
Base(<http://example.com/service#>)

Forall ?Applicant(
   act:decide(?Applicant <hsm_Regular>):-
?Applicant#per:applicant
   act:decide (?Applicant <hsm_Dutch_Graduate>):-
?Applicant#per:dutch_graduate
   act:decide (?Applicant <hsm_Foreign_Graduate>) :-
?Applicant#per:foreign_graduate
   )
```

Figure 3 demonstrates the interactions between the BPM engine and the Web services to create dynamically the process for regular HSM applications.

The use of our framework to translate legal knowledge into operational processes makes the processes more adaptive. If the income requirement is changed, the new income requirement can be easily adapted by changing decision related BRs. In case that a new type of applicants is added to the legislation, a new operational process can be created by adding a new decision service containing this logic and reusing the

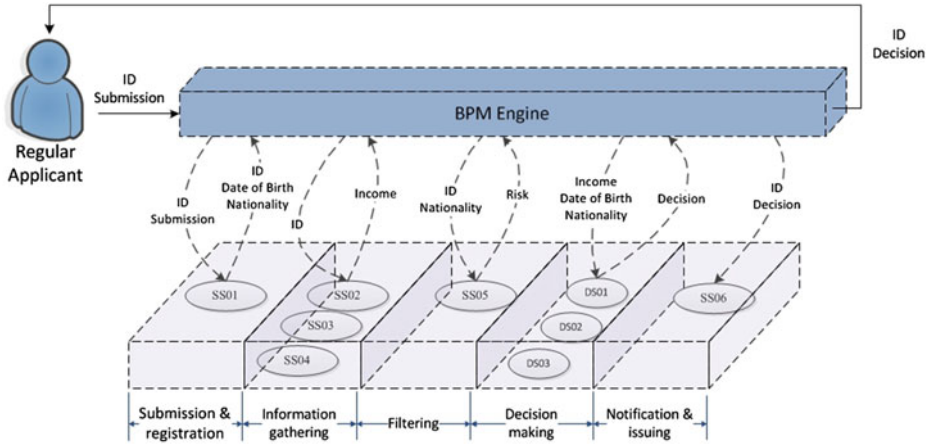

Fig. 3. An example of dynamic creation of the business process for regular HSM applicant

existing supportive services like income and diploma checking services, if they are applicable. Legal compliance can be maintained easily because the decision service only contain BRs derived from legislation and separated from supportive services for information gathering and other activities.

5 Conclusion and Future Research

With the aim of automatic creation of operational processes to satisfy requirements from frequently changed legislation, the proposed framework combines BR and SWS technology. The framework enables a clear integration of BRs between legal knowledge representation and operational levels and allows BRs to conduct the invocation of SWSs to create a business process. Web services are used as the way to manage resources which are invoked to create a process. SWS technology is used to describe decision and supportive services. Processes are created by a BPM engine that takes BRs as an input to invoke Web services making up a business process. When legislation is changed, BR can be easily updated in order to include the new or changed legislation in the process. This should not only allow to quickly adopt new legislation at low cost, but also ensure the compliance of business processes with legislation.

For future research, our framework can be used for a variety of legislation used in different settings and situations. A further research direction is to use the framework for translating strategy into operational processes to investigate its suitability for cross-organizational systems.

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