METHODOLOGICAL EXTENSIONS FOR SEMANTIC BUSINESS PROCESS MODELING

David de Francisco, Henar Muñoz, Noelia Pérez, Javier Martínez
Telefonica Research & Development, Valladolid, Spain

Ivan Markovic
SAP Research, Karlsruhe, Germany

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Abstract: Semantic Business Process Management (SBPM) aims, among other advantages, to facilitate the reuse of knowledge related to the definition of business processes, as well as to provide an easier transition from models to executable processes by applying semantic technologies to BPM. In this article the authors focus on extending the scope of knowledge being reused from executable processes to semantic models' scope. This is done by providing some methodological extensions to existing BPM methodologies in order to take advantage of semantic technologies during business process modeling.

1 INTRODUCTION

Business Process Management (BPM) is an approach to manage the execution of information technology-supported business operations (). Semantic Business Process Management (SBPM) (Hepp et al, 2005) extends the BPM approach by adopting Semantic Web technologies in order to bridge the gap between the business and technical perspective on supporting information systems. In this context, semantics tries to overcome i) the lack of formal representation of process models, which results in a more difficult transition from models to executable processes, ii) the unnecessary complexity of current business process models, and iii) a lack of reutilization which implies important time-to-market increase.

A simplified comparison between BPM and SBPM life cycles is depicted in Figure 1. BPM life cycle (depicted in continuous arrows) starts with process design (Weske et al, 2004) made by business analysts, which provides process models (1). These models are further translated by technicians (2) into executable processes (3), which are integrated with previous processes defined within the company by technicians (4). Semantic BPM life cycle (depicted in dashed arrows) designs semantically annotated models (1'), enabling reuse of previous models and the validation of their business context (2'). These models can be translated into executable semantic processes with less (or no) interaction from technicians (3'). The executable semantic processes can be composed (as Web services are) with other semantic processes in a more flexible way due to their uniform annotation (4').

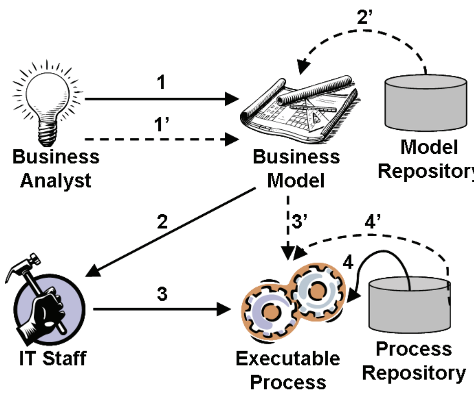

Figure 1: Comparison between BPM (continuous line) and Semantic BPM Life Cycles (dashed arrows).

Focusing on design steps (upper part of the picture), a need for adaptable methodologies to drive business process (BP) modeling is presented in (Roser and Bauer, 2005). Modeling is covered by

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several BPM methodologies, such as ARIS (Scheer, 2000), (Scheer, 1999), IBM (Wahli et, 2007), (IBM, 2006). However, the lack of a uniform notation in modeling tools brings model inconsistencies. That stimulated new proposals to share BP models (Yamamoto et al, 2005), to improve reusability and flexibility in BPM (Yao et al, 2006) or to optimize BP design in order to empower process redesign (Zhou and Chen, 2003).

Semantic technologies can overcome the lack of uniform representation, empowering the reusability of previous models as previously argued. In addition, semantic BP modeling offers some inherent techniques that are obviously not covered in current BPM methodologies, such as semantic annotation (Born et al, 2007), discovery (Markovic and Karrenbrock, 2007) , querying (Markovic et al, 2007) and composition of processes, in order to favor the reuse of BP models (Markovic and Pereira, 2007). That makes a specific coverage of such techniques necessary for semantic BPM methodologies.

The proposal of this paper focuses on the modeling phase, where a big gap in the translation between business requirements to process models still exists (Hepp et al, 2005). Therefore, we believe that a methodological coverage of steps 1' and 2' of Figure 1 is also needed. To address this requirement,,we propose some extensions to current semantic Business Process modeling methodologies which can favor the reuse of business know-how. These extensions add some sub-phases which complement existing methodologies and are currently being implicitly used by business analysts, such as BP patterns and model validation against business policies.

The authors will present a brief state of the art of current semantic and non-semantic BP modeling methodologies (Section 2). In Section 3 we illustrate the proposed methodology extensions with examples from telecommunication sector, as one of the business domains which could obtain more benefits from the better reusability due to the strong time-to-market requirements of this sector. The article concludes with an outlook on the usage of these methodology extensions in Section 4.

2 STATE OF THE ART

BP modeling phase is covered by most of the existing methodologies, e.g. ARIS (Scheer 200), (Scheer, 1999), IBM (Wahli et al, 2007), (IBM; 2006). The modeling life cycle is mainly formed by: requirement analysis from business analysts, process modeling by using a formal language, simulation and redesign (IBM, 2006). In addition, ARIS defines the five views of the knowledge (mainly focused on IT level) used during BP Modeling activities (Scheer, 2000): data (information objects and their relationships), organization (organizational structures and their relations), function (activities), product (input and output produced by activities) and control (process flow). However, the knowledge related to BP modeling is broader than current methodologies and languages can represent (Mou et al, 2004). Extending the representable knowledge of current methodologies and languages can provide several benefits to overcome the aforementioned weaknesses.

Within the SUPER project (ip-super.org), a methodology which covers the complete SBPM life cycle (from modeling to execution and analysis) has been defined (Fantini et al, 2006), and a proposal of methodological guidelines for modeling and configuration phases has been made (Weber et al, 2007). This proposal's objective is to facilitate the transition from BP models to executable processes, as well as the reuse of workflow (steps 3' and 4' of Figure 1). However, we argue that focusing BP modeling on getting only implementation benefits i) doesn't allow business analysts to fully define models, ii) doesn't capture all knowledge from a business perspective which is usually very relevant to a company and iii) misses a great opportunity to reuse and extend the business knowledge, as presented in the following section.

3 LIFE CYCLE PROPOSAL FOR SEMANTIC BP MODELING

In this section, authors propose a life cycle for semantic business process modeling. This life cycle, depicted in Figure 2, is based on the spiral life cycle model first proposed by Boehm (), which is widely adopted by BPM community due the dynamic nature of BPs and their consequent redesign cycle. The use of a continuous evaluation and improvement process (such as CMMI (Institute, 2007)) is recommended in order to define the procedures to ensure the quality of any artifact produced during semantic BP modeling (ontologies, models, patterns, etc.), and thus depicted in the outer ring of the picture. However, the definition of such a process is beyond the scope of this article.

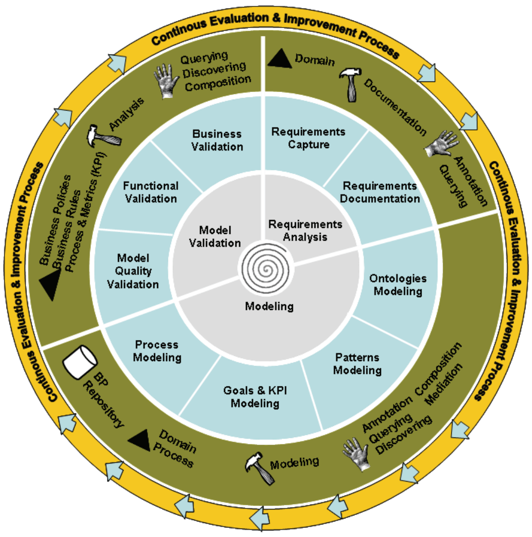

Figure 2: Semantic Business Process Modeling Life Cycle.

Phases, depicted as the inner ring, and sub-phases (next ring), are based on current BP modeling and software engineering life cycles (Pressman, 2005). Although some sub-phases are extensions to most commonly used life cycles, the major contribution of this life cycle comes from the application of ontologies, semantic tools and techniques, depicted in the third ring of the picture by a triangle, a hammer and a hand respectively. In following subsections we present each of the phases and sub-phases of the life cycle, providing a description, products which will be provided by this phase, ontologies and tools to be used, and the application and expected advantages of semantic techniques within each phase.

3.1 Requirements Analysis Phase

During the Requirements Analysis phase, business analysts collect all the relevant information for the BP design and further implementation. This information comes from various sources (e.g. the company's strategy, marketing and product departments, final customers, partners, etc.), and has to be collected and documented by analysts.

3.1.1 Requirements Capture

Requirements Capture is the phase in which a business analyst collects all the relevant information for a BP design and extracts requirements for the BP. The information taken into account comes from heterogeneous sources (e.g. meeting minutes, technical and business documents, etc.) and a common understanding between analysts and requirement providers is needed. The study of this information will discover business and technical needs that will be documented as requirements during the next sub-phase. During this phase, while technical specifications are being defined, knowledge is exchanged between business analysts, people from different departments/companies and technicians.

3.1.2 Requirements Documentation

This phase involves the documentation of requirements captured in the requirement analysis. It is composed by the requirement classification to support their traceability, as well as the refinement of the requirements specification, defining the functional and non-functional objectives to be covered by the BP. Output of this sub-phase is a requirement analysis document in which requirements for the BP modeling are documented as stated before.

There is no systematic way of documenting requirements. Most often the business analysts use Microsoft Word, Powerpoint or spreadsheets for documentation purposes. By providing a shared model (see 3.2.2), ontologies have the potential to structure the method of documenting requirements, enable their common understanding and provide the possibility for automated analysis. An ontology for requirements documentation as in (Jinxin et al, 1996) would allow e.g. for detecting redundancies and conflicts in the requirements specification. It would also enable gap analysis and easier traceability of requirements across the specification, by answering queries such as: *"What is the source of this requirement?"*

3.2 Modeling Phase

After requirements have been specified, the business analyst provides several artifacts as a result of the BP modeling. These artifacts are ontologies, BP patterns, goals and KPIs, and finally concrete BPs which will be translated to executable processes and run in further steps not covered in this article.

3.2.1 Ontologies Modeling

Requirement analysis phase produces a list of documented requirements which might affect the business ontologies being used during the modeling and validation phases (e.g. redefinition or new concepts, relationships, etc.). Business ontologies model different perspectives of processes, where we reuse the ontology framework described in (Markovic and Pereira, 2007), and domain-specific information (domain ontologies). The output of this sub-phase is the refinement of business ontologies according to the specific scenario. Note that many of the domain ontologies can make use of existing standards, like NGOSS (Reilly and Creaner, 2006) in the case of telecommunications sector.

3.2.2 Patterns Modeling

BP patterns are abstract BPs which are not fully defined in terms of concrete tasks and services, and thus can not be executed. These patterns capture the first draft of a process, making emphasis on the business goals and leaving the concrete definition of processes to a further step. They represent a solution to a well known problem, and a base to enable the extension to a concrete problem (as software design patterns do (Gamma et al, 1995)), providing best modeling practices.

The first step in defining a business process is to define objectives to achieve. This definition is commonly done by the definition of business process patterns, which can be defined from previous patterns or from scratch. BP patterns are implicitly used by business analysts when they want to define *what* a process should achieve without defining *how* this will be done. The patterns define high level goals (or milestones) and a simple workflow which connects them.

The objective of the formalization of these high-level models in our methodological extensions is to provide best practices for other business analysts and a common base for the specification of BPs which share a same sub-domain (e.g. all BP of a given product family share common features in their design).

Patterns are annotated with the context of their usage which is comprised of a business function, a business goal and a business domain. These annotations allow us to query for patterns in the early stages of modeling in order to provide modeling guidance. An example query for business pattern can be formulated in the following way: *"Give me all business patterns related to* <u>*Fulfillment*</u> *Business Function and* <u>*Client*</u> *and* <u>*Product*</u> *Business Domain where Business Goals involved are* <u>*profileObtained*</u> *and* <u>*serviceActivated*</u>*"*.

3.2.3 Goals and KPI Modeling

After the definition of the objectives which the BP being modeled has to accomplish, a business analyst usually refines those objectives in terms of business goals at the operational level (more concrete than the ones defined for the pattern), and assigns them to corresponding key performance indicators (KPIs). KPIs define the metrics used to monitor and measure the performance of business processes during execution time. Business goals and KPIs can be reused from previous models. The output of this phase will be the formalization of both business goals and KPIs, annotated according to the ontologies defined in the ontology modeling sub-phase.

Formal modeling of goals allows us to perform goal-based analysis of process models in order to detect redundancies and conflicts in process specifications. In addition, we could follow the dependencies (e.g. identifying which goals support or hinder the observed one) in the goal model. It also allows for improved traceability when changes in the environment occur. Through reflecting the changes on business goals, we are able to easily identify the processes which need to be adapted to the new requirements.

3.2.4 Process Modeling

Once business process objectives are clear, and the metrics used to measure its performance defined, the process is defined. Tasks and workflow can be defined by either i) deriving from previous BP patterns, ii) extending or refining previous BP models, iii) editing directly, or iv) any combination of the previous options, since BP modeling is often made in several steps which can mix up previous approaches. Once the process is defined, it is semantically annotated according to the ontologies defined in the ontology modeling sub-phase. Once the process is finished, we will have a complete BP model including the following artifacts: a BP model with semantic annotations, goal(s) and KPI it should fulfill, BP pattern(s) which derives from, if any, and ontologies which formalize the knowledge used to create the aforementioned artifacts.

The business process ontology (Markovic and Pererira 2007) and the domain ontologies defined in section 3.2.1 are used in querying for business process artifacts, which supports decision making and facilitates reuse of modeling artifacts (Markovic et al, 2008). Some example queries for the decision making support scenario include: *"Give me all processes in the fulfillment area"*, *"Which processes use system x?"*. Since process modeling is a complex activity, the reuse of existing models and model components makes sense in all stages of modeling. When reusing existing modeling artifacts, the analyst can reuse process fragments (self-contained, coherent building blocks of a process model with a clear business meaning) or existing process models which are similar to the desired model. Moreover, the analyst can substitute an existing process fragment based on redesign goals or auto-complete an underspecified model, by making queries on process annotations in the modeling tool (Markovic et al, 2008).

3.3 Validation Phase

Validation of BP models is a crucial phase in which it is ensured that the BP designed effectively covers the requirements captured in the first phase from both a functional and business perspective. Besides, quality of the model must be checked, ensuring that the model designed will derive in an executable process with high performance, and that the model is conceptually correct.

3.3.1 Model Quality Validation

This sub phase checks the model quality according to a set of metrics. These metrics heavily depend on the company and the continuous evaluation and improvement model they are following. Metrics can include complexity of the model, structure of the model, modularization, or cognition (Volker Gruhn, 2007).

Annotating processes using a common vocabulary (provided by ontologies from section 3.2.1) enables semantic evaluation of process models and leads to improved readability of the models not only for human beings but also for machines. This enables automation envisioned by the Semantic Business Process Management methodology. Furthermore, by using a shared vocabulary the abstraction conflicts are eliminated and problems caused by synonyms and homonyms are avoided, resulting in models of higher quality.

3.3.2 Functional Validation

This sub phase checks the coverage of functional requirements that the BP has to accomplish. Additionally, the workflow performance is usually tested by the simulation of the model, in order to detect possible bottlenecks at early stages of the BPM life cycle. The result of the validation brings new requirements for improving the BP model, which are taken into account in subsequent modeling iterations.

In this phase, we can utilize the formalization of the behavioral (dynamic) perspective of processes from (Markovic and Pereira, 2007) in order to perform formal verification of the correctness of the model. This includes deadlock and liveness checks on the model by using techniques from (Puhlmann, 2006) and also the step-by-step simulation of the process behavior (Puhlmann and Bog, 2006).Based on the results of the verification, business analysts can perform necessary corrections on process models in the early stages of the BPM life cycle.

3.3.3 Business Validation

Real BPs do not only have to accomplish certain functional requirements, but also are influenced by business policies and rules which are derived from the company strategy. Business policies orthogonally apply to all business processes of the company and can be mandatory or optional. Mandatory policies must be correctly addressed in BP models, while conditional ones are suggestions to improve or complement the model which can or can not be taken in consideration. Business rules affect the execution of the process, defining conditions which drive the execution of the workflow. Checking both elements usually provide new requirements for later modeling iterations as well.

Business policies can be annotated with the context of usage (business function, goal, domain) in order to retrieve all policies (both mandatory and conditional) which match context annotations of the model being checked. An example query can be formulated as: *"Give me all business policies for Digital Asset Management domain for minors where Business Goal associated belongs to Fulfillment"*. Information retrieved includes a textual explanation of the business policy as well as a control definition (subprocess) which explains how this policy should be included or taken into account in the model being checked. This helps us to ensure the correctness of the designed models. In addition, ontologies can be used to formalize business policies and the derived business rules in order to enable semi-automatic compliance checking of existing process models against relevant policies.

4 CONCLUSIONS AND FUTURE WORK

In this article, the authors have proposed new methodology extensions which emphasize the application of ontologies, by semantically enhanced tools and techniques with the aim of reusing business knowledge and therefore creating models of higher quality, speeding up business process modeling while reducing error-proneness of the task. These extensions complement current methodologies, adapting them to the use of semantics in business process management. In the near future, the authors will design a validation plan for these extensions, with the aim of extracting some empirical conclusions about the usage of the proposal within the telecommunication sector.

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