Business Process Knowledge Integration – A Semantic Based Approach

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Abstract: Knowledge about business processes is one of the most important assets of a modern organization. The knowledge about how an organization works, achieves its business goals, satisfies its customers' requirements and how agile the company is in these respects is essential for its various stakeholders inside and outside of the organization. However success of process management initiatives is highly dependent on the quality, completeness and expressiveness of the knowledge acquired. This knowledge is distributed, consists of different types and expresses different levels of abstraction. Its acquisition and collection into a common knowledge base, which implies integration into a single model, is the goal of the approach proposed. In this paper a framework for the integration of business process knowledge is proposed. It is shown how semantic technologies can contribute to the integration of different models, which represent different aspects of an organization, in order to create a better model of business process knowledge.

Keywords: Business Process Management, Business Process Knowledge, Interoperability, Integration, Semantic Technologies, Ontology
Categories: I.2.4, I.2.6, K.4.3,

1 Introduction

In the last few decades business process management has received a lot of attention in the scientific as well as in the industrial world. Current market studies e.g. (Anderer and Châlons 2006; Wolf and Harmon 2006) point out its importance for organizations. On the other hand organizational practice and market analysis reports still show a large gap between process descriptions (how an organization wants to function) and their working practice (how organisation actually operate). In this paper we address one of the key reasons for that problem: inappropriate process models.

The knowledge necessary for the modeling of better "to-be" models is heterogeneous, and distributed among people, documentation and systems. The critical connections or dependencies are not always obvious or defined. Beside isolation, parts of that knowledge can be frequently also found outside the boundaries of organizations.
Often, essential parts of the relevant information about organization and business processes necessary for the creation of the process models are not considered in the design process. Dependencies between them are overlooked or misunderstood, and

key participants with significant knowledge and experiences are excluded from the design process. Consequently, deficient understanding of the organization leads to the creation of process descriptions and process models, which can not be followed and carried out in the organizational practice.
On the other hand process models, even if they are feasible, are mostly designed for only one stakeholder. They are therefore described in an inappropriate description language, have inappropriate scope and form to be used for the proper communication to different stakeholders on operational and on strategic level. Process models that cannot take into account process stakeholders' perspectives can hardly be expected to be easily communicated and properly applied.

For the successful management of process knowledge (knowledge about the organizational processes) it is necessary to treat it in a broader context (Hrastnik, Cardoso et al. 2006). One of the possible solution for the generation of an integrated and more expressive business process knowledge model that aggregates stakeholder's perspectives is to relay on semantic technologies.
Semantic technologies can extend capabilities and value of information. The four main reasons that make semantic technologies suitable to approach the identified problems are (Noy and McGuinness 2001): (1) to share a common understanding of the structure of information among people or software (this way, the model can be understood by humans and computers); (2) to enable reuse of already specified domain knowledge; (3) to make domain assumptions explicit (concepts defined in the model have a well-defined and unambiguous meaning); (4) analysis of domain knowledge is possible once a declarative specification of the terms is available. Models with richer semantic relationships and strict rules offer a more powerful and flexible basis for knowledge integration, modeling and communication. Additional benefits for combining of business process management with semantic technologies can be find in (Hepp, Leymann et al. 2005).

In this paper we propose an extendable framework for business process knowledge integration, which uses the advantages of semantic technology to enable a mapping and integration of different models into a common knowledge base with the help of an ontology. Those independent models are parts of business process knowledge and present aspects, dimensions, or abstraction levels of an organization. Once integrated in a new model, they provide a better basis for better business analysis and creation of more suitable process models and improved process knowledge communication.

This paper is structured in the following way: the first part presents the challenges regarding business process knowledge management. The problems regarding process models and current approaches and solutions are discussed. In section 3 our integration approach for achieving better process models is introduced. The framework architectural design and technologies used are shown in section 4. In the following section possible extensions for the introduced framework are presented. The last section summarizes the paper and concludes with plans for future work.

2 Background and Motivation

There are various reasons why organizations model different aspects of their organizations. Apart from analysis, process automation, simulation and documentation, the creation of "guidelines" (for fulfilling the organization's strategy, goals, regulatory, compliance, quality standards and above all customer requirements) is one of the most frequent reasons for modeling.

The knowledge necessary for the creation of process models must be collected at several levels within and outside the organization; respecting its unique structure, people and culture. In the modeling process, organizations are confronted with different kinds of difficulties and constraints (Habermann 2001). Knowledge about processes is distributed, heterogeneous, isolated, expresses at different level of abstraction and scopes, and is often contradictory. Language barriers between people with different professional backgrounds represent sometimes unbridgeable worlds. Gaining critical and important information for process model creation is therefore a complex, time-consuming task, which can be never complete.

Current enterprise and business modeling approaches, tools and modeling languages which in specific contexts and different focuses address buisness process modeling can only partialy fulfill important requirements regarding integration and communication of business process knowledge. Established process modeling languages (e.g. BPMN(OMG 2006), BPEL (BPEL 2007), UML (OMG 2005)) do not cover all the important concepts or knowledge elements (Fadel and Tanniru 2005) which critically contribute to the expressiveness of the process models. Because of specific purposes and design objectives of modeling languages process models created with them support only limited number of perspectives (Curtis, Kellner et al. 1992). Extensions to modeling languages have been proposed (e.g. process goals and performance measures (Korherr and List 2007)). The enterprise modeling approaches which usually include the process aspect do not offer methods for its integration with the other aspects of the organization to be modeled. Zachman Framework (Zachman 1987)) offers the classification and propose modeling languages for different layers only as examples and do not specify them in detail. Therefore the "bridges" between different layers cannot be easily established. Also popular enterprise modeling tools (e.g. Aris Process Platform (IDS-Scheer 2005) or ProVision Modeling Suite (Proforma-Corporation 2007) do not integrate the various models or provide only very loose connections between them (Hepp and Roman 2007). Some approaches which offer comprehensive integration (e.g. MEMO (Frank 2002)) introduce new modeling languages for perspectives and aspects of organization to be modeled.

3 Integration Approach

To enable a systematic approach, the business process knowledge framework was proposed (Hrastnik, Rollett et al. 2004). It considers business process knowledge (Hrastnik, Cardoso et al. 2006) as a super set of conventional business process models and also includes knowledge about the motivation behind processes, reasons for their

existence, knowledge about constraints, the required resources for their execution, as well as its interfaces, process environment, capability, performance and documentation. The systematic approach includes the following management steps: acquisition, synthesis, and communication. In this paper, as a part of the synthesis step, we propose business process knowledge integration.

In our solution we propose a pragmatic procedure for achieving better process models that do not require additional effort or changes to workflow within the organization. The goal of building better business process models and knowledge can be achieved iteratively by enriching the process models designed with information captured in other knowledge sources already available in the organization. Different organizational roles either at strategic or operational level design and model various aspect of the organization, important for their part of work (e.g. strategy, people, resources, data). In order not to require additional work, we use those specific models in the form in which they usually already available (e.g. from standard business software file formats). The specific models describe an aspect or a layer of the organization or business (e.g. goals tree, value chains, organizational chart) at different levels of abstraction or a specific view on it. They often include knowledge which represents a relevant part of or constraints for the business process knowledge model.

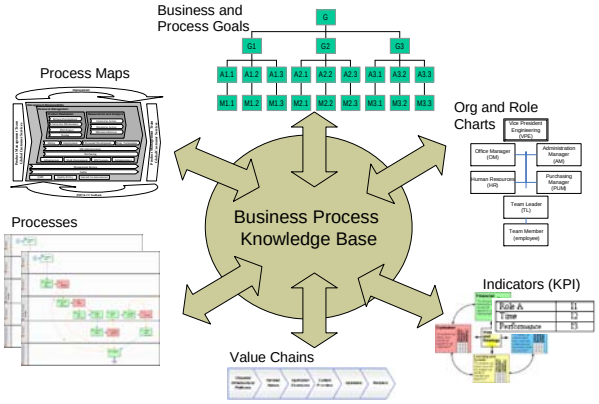

*Figure **1**: **Models integration***

In support of the creation of a common business process knowledge model, all applicable knowledge captured in specific models is mapped in to a common description language and integrated into a single model. How different knowledge elements from specific models relate to each other and to the knowledge elements in the knowledge base is defined by business process knowledge meta model, in our case an ontology. In the integration process, for the knowledge base relevant knowledge elements of the specific models are merged with the ones already available in the knowledge base (e.g. business goals with process goals, process goals with process models, process models with corresponding measurement categories and indicators). The integration works in the same way for models representing the same organizational aspect, but different levels of abstraction (e.g. process models from

different levels of processes hierarchy). It is important to consider that knowledge elements of different models often overlap. Therefore, additional merging rules, which are not part of the ontology have to be defined. Depending on the usage of the knowledge base, the extraction and backward mapping into the specific model structure format is needed. Because of the transformation from semantic richer model (relations or properties which specific models not support) into specific format, for such a step a special consideration is required.

4 Overall System Architecture and Applied Technologies

The system architecture for the implementation of the integration framework comprises the following basic parts (Figure 2): (a) business process knowledge ontology, (b) mapping files repository, (c) mapping and integration component, (d) extraction and mapping component.

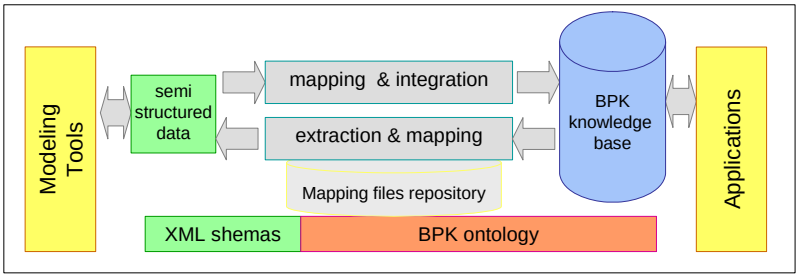

Figure 2: System Architecture

Business process knowledge ontology defines the concepts, their properties, and the relations between them. In the framework implementation it serves different purposes. It is applied by the *mapping & integration* component as the guideline for models integration. Together with schemas files, which describe the format structure of the models, is used for the definition of mapping files.

The *mapping files repository* consists of a collection of files in XSLT standard format (W3C 1999). They define the linking between of in particular model covered concepts and the concepts and properties defined in the BPK ontology. The mapping files have to be created separately for each particular model (which can have a standard or a tool specific format) and for each direction of mapping. The necessary requirement for the modeling tools is therefore the export of models into a semi-structured data format. Most of current modeling tools support the export in XML format (W3C 2006), therefore the framework can support most of the open source and commercial modeling tools. The mapping files can be created manually with a XSLT editors or semi-automatic (Cardoso 2007). For semi-automatic creation of the mapping file the tool specific XML schema (W3C 2004) is required.

With help of mapping files the *mapping & integration* component transforms the particular models into RDF/OWL (W3C 2004) format and integrates them into the knowledge base. For the integration into the knowledge base the relations and constraints defined in by ontology are applied. *Extraction and mapping component*

manage the extraction of the model specific concepts from the knowledge base and map those into a tools specific format.

The prototype tool under development implements the described architectural design. For that purpose the BPK ontology in OWL Web Ontology Language (W3C 2004) was created. The iterative approach was applied. In the first phase the initial version of the ontology was created according to the (Hrastnik, Rollett et al. 2004), based on business process meta models (e.g.(List and Korherr 2006)) as well as with help of the existing business process and enterprise ontologies (e.g. ((Jenz 2003), (Uschold, King et al. 1998)). In a second phase, the business process knowledge ontology was refined and extended with concepts and properties gained from particular models, whose mapping is already implemented (e.g. XPDL (WFMC 2005)).
Presently the prototype supports the mapping of specific models which represent the process functional, organizational, and strategic perspective and provide basic integration functionality.

5 Framework Adaptability

The proposed integration framework is open to extensions or improvements in several ways. In case of adding *new concepts*, *concept properties* or additional *relations* between existing concepts, the BPK ontology can be extended by adding new elements and by defining their context with creation of the proper relations. If the new elements can be included in one of the specific models, the corresponding mapping file has to be updated. Another possibility of re-configuration refers to adding *new specific model*, e.g. organizational resources, which in the current BPO are covered only partially. In that case an appropriate modeling tool has to be selected. Considering the structure format in which the new models will be exported, the bidirectional mapping files have to be created (see previous section). If required BPK ontology have to be upgraded with the missing elements. The same procedure can be applied if a *new modeling tool* is introduced.

6 Conclusion and Future Work

Organizations have to deal with heterogeneous, distributed, isolated, misunderstood, and often inaccessible process knowledge. Current modeling approaches as well as process modeling languages do not completely fulfill the requirements regarding business process knowledge management. In this paper we propose an adaptive framework for business process knowledge integration. The novelty in the work is its semantic technology support for enabling the mapping and integration of different organization aspect models into a common knowledge base. The business process knowledge base created in the proposed way can enable process knowledge analysis (discovering dependencies and dealing with conflicts), and because of more flexible and powerful relationships at the same time provide a basis for creation of multiple perspectives (personalized views) on the model.
Our further work in this respect includes the completion of the current framework prototype implementation, proposed in this paper, as well as accomplishment of the

industry case studies in the organizations which participate in the research project. The special research focus will be set on possible solutions regarding rules for automatic integration.

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