Metamodeling Architectures for Business Processess in Organizations

Alfonso Pierantonio[1], Gianni Rosa[1], Darius Silingas[2], Barbara Thönssen[3], and Robert Woitsch[4]

[1] Dipartimento di Ingegneria e Scienze dell'Informazione e Matematica
Università degli Studi dell'Aquila (Italy)
[2] No Magic Europe
Savanoriu av. 363, LT-49425 Kaunas (Lithuania)
[3] University of Applied Sciences Northwestern Switzerland
Riggenbachstrasse 16, CH-4600 Olten (Switzerland)
[4] BOC Information Technologies Consulting AG
Operngasse 20b, 1040 Wien (Austria)

Abstract. This paper presents the working version of Learn PAd metamodel that captures the concepts that are used to model process-centric business architecture (process, motivation, organization structure, measurements, etc.) in sufficient detail to be useful for on-the-job learning in public administrations. We provides detailed concepts and relationships reusing selected parts of the modeling standards such as BMM, BPMN, and CMMN when possible. The interrelationships between the concepts in different metamodels are captured in a separate weaving model in order to enable encapsulation of separate views that could be specified using isolated standard metamodels.

1 Introduction

In modern society public administrations (PAs) are undergoing a transformation of their perceived role from controllers to proactive service providers. In most cases, the provisioning of the services is a collaborative activity shared among different, possibly many, organisations that are in general quite interrelated. Civil servants are challenged to understand and put in action latest procedures and rules in order to constantly improve their service quality while coping with quickly changing contexts (changes in law and regulations, societal globalization, fast technology evolution) and decreasing budgets.

In order to provide efficient services to citizens and companies, civil servants have to manage and master extremely complex processes in PAs. The Learn PAd[5] project [3] aims at developing a social, collaborative and holistic e-learning platform able to foster cooperation and knowledge-sharing for civil servants. It enables process-driven learning and improvement of the process on a user-friendly basis of wiki pages enriched with additional documentation for a clearer understanding of the process together with

[5] Model-Based Social Learning for Public Administrations is part of the program FP7-ICT-2013.8.2 Technology-enhanced learning. The project started on Feb 1, 2014 and terminate on Jul 31, 2016 with a cost of € 3,535,000. For further detail please refer to http://www.learnpad.eu

guidance based on formalized models. Moreover, the platform supports both an informative learning approach based on enriched Business Process [13] (BP) models and a procedural learning approach based on simulation and monitoring *learning-by-doing*. To this end, it is of crucial relevance that the procedural aspects of a business process are described in accordance with other relevant views of the social and business context including organizational details, motivational intents, and measure indicators to assess the learning and the process enactment performance.

Model Driven Engineering (MDE) [15] is increasingly gaining acceptance as a mean to leverage business logic and make it resilient to technological changes. Coordinated collections of models and modelling languages are used to describe software systems on different level of abstraction and from different perspectives. In this paper, we describe some the outcomes and the objectives of the Learn PAd WP3: Approaches Enabling Model-based Learning [3]. The workpackage main objective is to define a comprehensive modeling language, called Learn PAd Metamodel (LPMM), for the specification of business processes in Public Administrations consisting of a number of *component metamodels*. Each LPMM metamodel focuses on a different aspect of the business processes. A process is typically perceived as a sequence of activities that the administration executes in order to produce a service for the end user. However, these activities are most of the time knowledge-intensive and require transparency and information tracing. In addition, the responsibility of their enactment is assigned to organizational units within the administrations which pursue given goals. Therefore, in order to better support the learner the typical business process modeling has been intertwined with additional modeling structures to make knowledge relevant in a given process explicit.

Structure of the paper. The paper is organized as follows: in the next section, we describe the main concepts for knowledge-intensive processes in PAs. The model-driven approach is discussed in Sect. 3, it has been used to formalize the Learn PAd metamodels provided in Sect. 4. Finally, in Sec. 5 we show a correspondence between metamodels by means weaving models and in Sect. 6 we draw some conclusions.

2 Processes in Public Administrations

A business process can be regarded as a sequence of activities that the administration executes in order to produce a service for the end user: it starts with i) receiving of some input (i.e. request, documentation), ii) performs activities that add value (i.e., checks) using resources (i.e., humans, information, structures), and finally iii) produce an output. Business processes in PAs are mainly knowledge-intensive. Thus, civil servants are used to dealing with huge amounts of information: lessons learned in previous engagements, insights from prior projects, notes for subsequent process steps are scattered among manifold knowledge containers, from the personal memory, over paper, to different electronic systems. In order to manage such information, it is important to organize knowledge archives exploiting the usage of BPs in a context-giving structure. In particular, the civil servant should be able to access the required knowledge in an optimal manner. This can be achieved by coupling the process model with the descriptive units about various aspects including the kind of data and document type being considered by the process, the organizational structure, the indicators for measuring both the performance of civil servants and how far the learning goals are achieved. The outcome of such modeling procedure is a number of interrelated models as depicted in Fig. 1. The specification of business processes (Fig. 1.a) is usually done by means of standard notations like BPMN 2.0 [13], while for knowledge intensive (sub-)processes (Fig. 1.b) the Case Management Model and Notation (CMMN 1.0) [11] has been considered with some necessary adaptations in order to deal with partiality of information and some intrinsic uncertainty [7]. Another aspect, which is relevant for Learn PAd, is the necessity to consider business goals, Key Performance Indicators (KPIs) and success factors, which are usually represented in a Business Motivation Model (Fig. 1.c) (BMM) [12]. The learning competencies required by roles are modelled as well: the Competency Model (Fig. 1.d), based on the framework CEN [8] is built for describing learners level of competencies, learning progress, etc. Organisational units, roles and persons are modelled in an extra Organisation Model (Fig. 1.e), to allow for more expressiveness than 'BPMN native' pools and lanes, as the BPMN 2.0 specification, for instance, does not provide any semantics to lanes and pools (which are merely regarded as an encapsulation mechanism for organizing activities). Finally a Document Model (Fig. 1.f) is depicted, comprising application documents and data, learning reports etc.

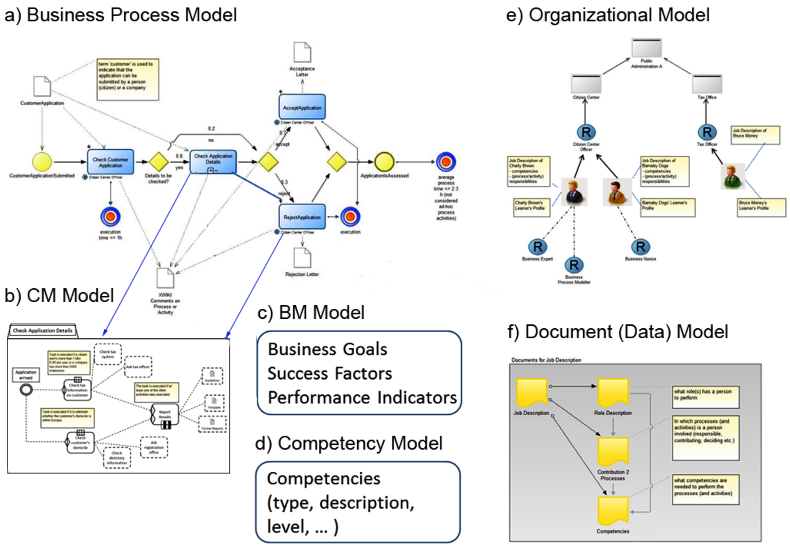

Fig. 1. Overview of needed models

Since, modeling notations are usually given in terms of metamodels a brief introduction to metamodeling and Model-Driven Engineering is given in the next section.

3 Background

In this section we describe the model-driven techniques, which has been used to formalize the Learn PAd metamodels and the correspondences among the different component metamodels.

3.1 Metamodeling

In MDE metamodels consists of a coherent set of interrelated concepts, which are used for formalizing an application domain. A more precise definition, as provided by Seidewitz in [16], is

> *a specification model for a class of system-under-study where each system-under-study in the class is itself a valid model expressed in a certain modeling language.*

Thus, domain instances can be expressed in terms of models, which are said to conform to a metamodel. The expressiveness of the metamodel, i.e., the amount of detail which has to be captured for each concept is a trade-off between abstraction and automation, i.e., the kind of applications (e.g., model-to-model and model-to-code transformations) the designer is aiming at. Being able to define the right generic-specific balance is key to success: a too generic language does not usually offer enough semantic graduation for distinguishing different concepts, on the contrary a too specific language, with too many concepts is difficult to learn, understand, manage, and deploy. In practice, a metamodel often evolves towards a final form only after it undergoes an iterative restructuring and refinement process. Each iteration consists in extending and refining the set of available features and adapting the corresponding model transformations and tools which are tightly coupled with the metamodel.

3.2 Model Weaving

The separation of concerns in software system modeling avoids the construction of large and monolithic models which could be difficult to handle, maintain and reuse. At the same time, having different models (each one describing a certain concern) requires their integration into a final model representing the entire domain [14]. Model weaving can be used in this scenario. Although there is no accepted definition of model weaving, in [4] it is considered as the operation for setting fine-grained relationships between models or metamodels and executing operations on them based on the semantics of the weaving associations specifically defined for the considered application domain.

The definition of model weaving that will be considered in this paper is that provided in [9]. The weaving metamodel is not fixed since it might be extended by means of a proposed composition operation to reach dedicated weaving metamodels. In a weaving model `WM` representing the mapping between the metamodels `LeftMM` and `RightMM` is given. Like other models, this should conform to a specific weaving metamodel `WMM` (see Fig. 2). In the context of Learn PAd we use the weaving models for specifying some form of *semantics* of given modeling elements. For instance, in BPMN the semantics of *lane* is not precisely given, therefore we give a weaving model which can associate a lane to an *organizational unit* deferring the semantics of the former to that of the latter. This technique is a simplification of the *semantic anchoring* [5] which adopts model

Fig. 2. The analysis process

transformations for anchoring the meaning of a concept in a metamodel into a concept in another metamodel (for which typically the semantics is already given)[6].

4 Learn PAd Platform-Independent Metamodel

The Learn PAd Metamodel (LPMM) is a comprehensive modeling language for the specification of business processes in Public Administrations consisting of a number of component metamodels as illustrated in Fig. 3. The following component metamodels

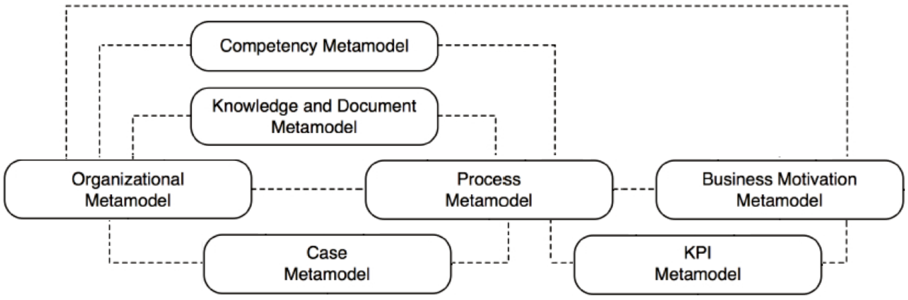

Fig. 3. The Learn PAd metamodel

have been defined by adapting current industrial standards:

– business motivation metamodel[7] (BMM) [2],
– business process management and notation (BPMN) [13], and
– case management and notation (CMMN) [1].

Due to space limitations we omit the detailed description of the above metamodels and the interested reader can refer to their standard specifications. The remaining metamodels have been defined from scratch and are described in the following subsections.

– competency metamodel (CM);
– document and knowledge metamodel (DKM);
– key performance indicator metamodel (KPI), and
– organization metamodel (OM).

The dotted lines in the figure denote the correspondences across the different views describing the manifold nature of a process, i.e., concepts belonging to two or more metamodels are cross-linked by means of weaving models [6] (see Sect. 5).

4.1 Competency Metamodel

The Learn PAd Competency Metamodel is thought for describing learners level of competencies and learning progress. In Public Administrations competencies are of-

[6] Weavings are often considered ”declarative transformations” since they define relations from which (specialized) transformations can be automatically derived (see [10]).
[7] In order to stress the distinction between model and metamodel we prefer to use the term metamodel also for denoting standards like OMG’s BMM, which we call Business Motivation Metamodel.

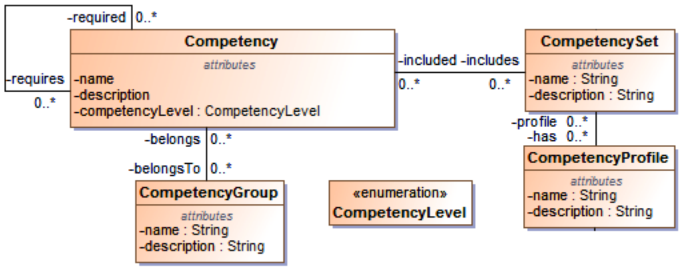

Fig. 4. The Competency metamodel

ten described within job descriptions but not defined in specific models leaving to the modeler the responsibility of consistently meeting them. The Learn PAd Competency Model permits the explicit modeling of such aspect. It is partly based on the framework the European Committee for standardisation, CEN WS-LT LTSO (Learning Technology Standards Observatory)[8]. In particular, it has been simplified in order to avoid any modeling element which is not necessary in the context of Learn PAd. Clearly, the Learn PAd Competency Metamodel plays its crucial role when connected with the business process metamodel desribed above and with the organisation metamodel. Such connections are specified by means of weaving models [6] which represents how model elements in a metamodel correspond to model element in another metamodel by means of typed many-to-many cross-links. An example of the Learn PAd weaving models is given in Sect. 5.

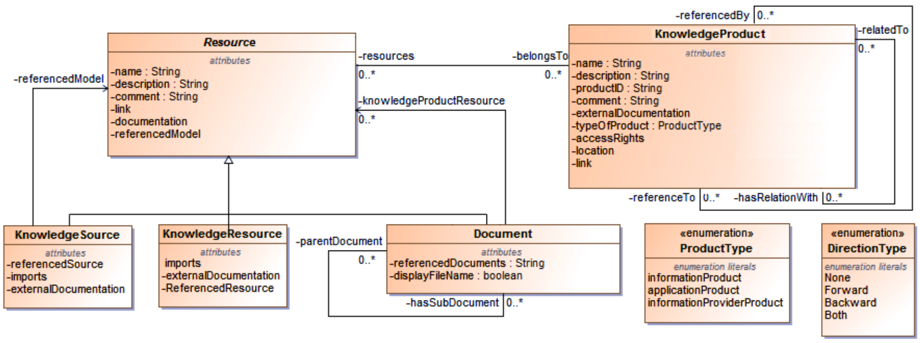

Fig. 5. The Document and Knowledge metamodel

4.2 Document and Knowledge Metamodel

Knowledge models contain documents (templates), knowledge products and resources, which are utilized in the processes (input, output to activities etc.).

Knowledge models can be built hierarchically using document sub models to e.g. illustrate a detailed structure of documents.

[8] EN WS-LT Learning Technology Standards Observatory. URL: http://www.cen-ltso.net/Main.aspx. Main contact: Uni- versity of Vigo 36213 SPAIN.

4.3 The Key Performance Indicator metamodel

Key Performance Indicators (KPIs) are seen as a virtualisation instrument enabling to conceptualise relevant parts of the concrete instances of the production processes. A performance indicator is a measurement of the success of a given organization or activity in which it engages.

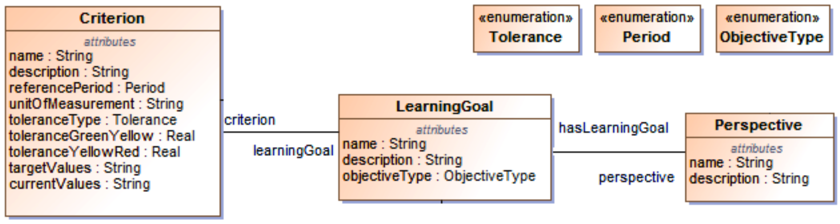

Fig. 6. The KPI metamodel

Thus, KPIs can be successfully employed in process models in order to assess performance of activities and processes. Besides making the KPI modeling explicit by means of the metamodel which is illustrated in this section, we aim at relating KPIs to activities and to the process as a whole. Therefore, proper weaving models will be given in Sect. 5 connecting the KPI metamodel and the business process metamodels and the business motivation metamodel.

In the following the class diagram of the KPI metamodel is given and all the concepts are introduced by specifying the characterizing features.

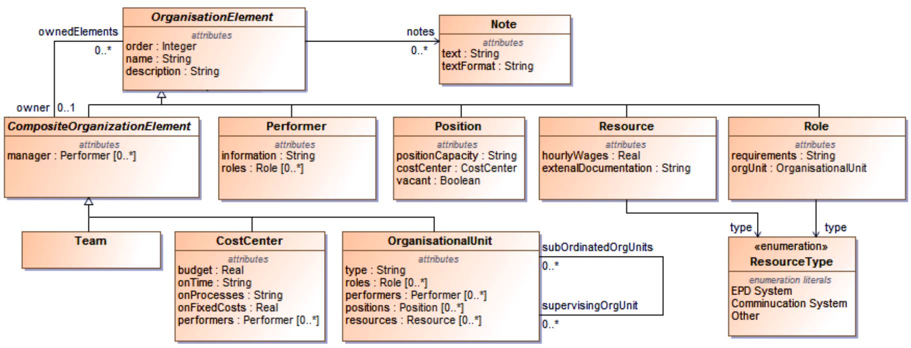

Fig. 7. The Organizational Model

4.4 Organization Model

Organization models describe the structure of an organization (organization chart). Organizational structure models can be built hierarchically using organizational sub models to e.g. illustrate a detailed structure of a working environment.

5 Weaving definition

As already said, weaving models are typically used for defining correspondences between modeling elements belonging to different metamodels and usually depend on each other. In the following, the weaving models, given by means of a weaving metaclass, are used for interconnecting the component metamodels. In the following a fragment of the weaving metamodel which interconnects a BPMN lane in the Perfomer of the OrganizationalUnit metamodel is depicted.

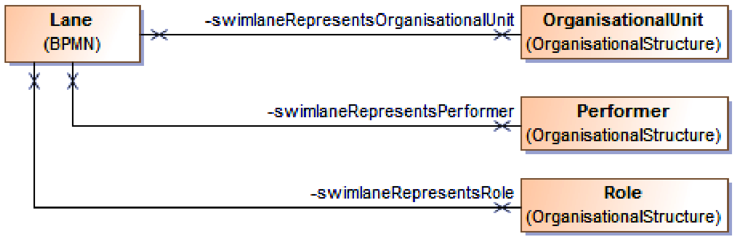

Fig. 8. The Swimlane-Lane weavings

6 Conclusion

This paper described how business processes in PAs can be described according to the Learn PAd modeling notation: a metamodel stack whose components are model kinds intertwined by means of weaving models. Such specialized models relates the several views a process one with another by means of formal correspondences that can be navigated or used for consistency checks. For instance, it has been possible to specify that the typical concept of a lane in BPMN must correspond to either an organizational unit, a performer, or a role. This is one of the most important criteria we had to follow because BPMN alone does not say anything about the meaning of lane. Future work includes the activities related to the continuation of Task 3.2. This time will be devoted for the design of the modeling tools and for the metamodel validation.

References

1. OMG. Case Management Model and Notation (CMMN), V 1.0. Technical report, Object Management Group OMG, 2013.
2. OMG. Business Motivation Model (BMM). Technical report, Object Management Group OMG, 2014.
3. A. Bertolino. Model-based social learning for public administrations (learn pad). eu-fp7 project. description of work, 2014.
4. J. Bézivin. On the unification power of models. *Software & Systems Modeling*, 4(2):171–188, 2005.
5. K. Chen, J. Sztipanovits, S. Abdelwalhed, and E. Jackson. Semantic anchoring with model transformations. In *Model Driven Architecture–Foundations and Applications*, pages 115–129. Springer, 2005.
6. M. D. Del Fabro, J. Bézivin, F. Jouault, P. Valduriez, et al. Applying generic model management to data mapping. In *BDA*, 2005.

7. R. Eramo, A. Pierantonio, and G. Rosa. Uncertainty in bidirectional transformations. In *Proceedings of the 6th International Workshop on Modeling in Software Engineering*, pages 37–42. ACM, 2014.
8. European Committee For Standardization. A European Model for Learner Competencies. 2005.
9. M.Didonet Del Fabro, J. Bézivin, F. Jouault, and P. Valduriez. Applying Generic Model Management to Data Mapping. In V. Benzaken, editor, *21èmes Journées Bases de Données Avancées, BDA 2005, Saint Malo, Actes (Informal Proceedings)*, 2005.
10. M.Didonet Del Fabro, J.Bezivin, F. Jouault, E. Breton, and G.Gueltas. AMW: A generic Model Weaver. In *Int. Conf. on Software Engineering Research and Practice (SERP05)*, 2005.
11. OMG. Case Management Model and Notation (CMMN), V 1.0. Technical report, Object Management Group OMG, December 2013.
12. OMG. Business Motivation Model (BMM). Technical report, Object Management Group OMG, 2014.
13. B. P. M. OMG. Notation (BPMN) 2.0. *Object Management Group: Needham, MA*, 2494:34, 2011.
14. T. Reiter, E. Kapsammer, W. Retschitzegger, and W. Schwinger. Model Integration Through Mega Operations. 2005. accepted for publication at the Workshop on Model-driven Web Engineering (MDWE2005).
15. D. C. Schmidt. Model-driven engineering. *Computer*, 39(2):25, 2006.
16. E. Seidewitz. What models mean. *IEEE software*, 20(5):26–32, 2003.