The Comprehensive Modelling of BPMN Business Processes and Business Rules using SBVR Profile

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1 STAGE OF THE RESEARCH

In order to have the comprehensive business process models we have to consider them together with business rules, i.e., we must apply two different modelling approaches that reflect two complementary aspects of the problem domain. The goal of this research is to embody the idea for the comprehensive integration of BPMN processes with SBVR business vocabulary and business rules in the modelling environment of CASE tools, and keeping the links among elements of these models. In order to achieve the goal, the process was established how to use the SBVR business vocabulary while creating graphical BPMN process models, and the transformation rules were defined that allow to transform business process model to business vocabulary and business rules representing BPMN business process. Currently, the efforts are concentrated on implementing transformations in the QVT transformation language.

2 RESEARCH PROBLEM

Information system (IS) projects usually start from defining business vocabulary and modelling business processes that serve for the development of further, more detailed IS models till their implementation. The business vocabulary and business processes help to reach the shared understanding between domain experts and software developers. However, CASE tools still lack means for modelling business vocabulary, which often is not properly documented. Nowadays, modelling of business processes is hard to imagine without the business rules, which are closely related with business vocabulary. Therefore, modelling of business processes and business rules related with business vocabulary are one of the most important challenges in developing information systems. Having such means in CASE tools, requirements can be captured in the natural language and used to create business process models, integrated with business rules, which also are presented in the limited natural language understandable for business participants. So business experts are able not only to present their requirements in the clear and precise way, but also to validate created business process models and ensure their compliance with actual business rules.

The problem of modelling business processes and business rules, related with business vocabulary, has already interested many scientists and practitioners. Current work is concentrated on creating methodology and practical means for achieving the comprehensive solution for this problem. For doing this, it is necessary to answer the following research questions:

1. How to make the right separation between graphical business process models and textual business rules models? This question arises because processes also can be modelled in a declarative way, as well as business rules can be entangled into business process models.
2. Is it possible to represent all business rules related with modelling BPMN processes by using standard SBVR vocabulary without extensions?
3. How to precisely relate business vocabulary with business process elements without applying linguistic analysis, which is appropriate to avoid?
4. Is it possible to define and implement reversible and lossless transformations between BPMN business process models and SBVR business vocabulary and business rules?

3 OUTLINE OF OBJECTIVES

The goal of this research is to allow creating the

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comprehensive BPMN business process and business rules models based on SBVR business vocabulary implemented in CASE tools, linking them to each other and eliminating the gaps that occur due to the different modelling approaches, the lack of integration and common modelling environment.

For reaching this goal, the following tasks must be fulfilled:

1. Analyse existing research works and practices related with modelling methodologies, languages, metamodels and modelling tools for business processes, business vocabularies and business rules.
2. Define the methodology, based on the SBVR business vocabulary, for right separation, formulation and linking business rules, expressing process control flows that should be represented by graphical models, and business rules, representing structural and behavioural constraints that should be represented by the structured natural language.
3. Define transformation rules and algorithms that would allow obtain the complete SBVR vocabulary describing BPMN process rules and behavioural constraints.
4. Implement transformation between BPMN and SBVR models based on SBVR profile, and interface between business rules' specifications in the chosen CASE tool and SBVR Editor.
5. Carry out an experiment and evaluate the results.

4 STATE OF THE ART

As business process modelling defines dynamic aspects of business domain and business vocabularies and rules define static aspects, these two modelling approaches are giving us a challenge to combine them and use together (Mickeviciute et al., 2013). These two modelling approaches should be kept together as complementary (Hohwiller et al., 2011) to each other in order to have the comprehensive representation of problem domain.

Analysis of combination of business process and business rules revealed that there are various proposals on this topic and there is a need to use these two modelling approaches together. Some of them are more theoretical then practical, other proposals lack of implementations or comprehensive information how to implement them. All of them have their own advantages and disadvantages.

Analysis of Visual SBVR (Musham et al., 2008) and the modelling method of Ross (Ross, 1997) has shown that even if there is a possibility to express business rules in a graphical notation, the method is not practical, due to the large set of graphical elements. Furthermore, there is no guidelines how to link business rules to business process elements.

Sinur in Gartner group report (Sinur, 2009) presented seven scenarios for using business rules in business processes. Later, these seven scenarios were critically reviewed and reduced to four key patterns (Koehler, 2010) for using business rules. The given thoughts of how business rules could be used in business processes are of theoretical nature, especially the last and the most complex scenarios.

The method for declarative business process modelling was presented by Vanthienen et al. (2007). However, business process models are better understood when they are modelled in the procedural manner (Schacker, 2006; Ceponiene et al., 2009; Nemuraite et al., 2010; Knowgravity, 2012). Business rules templates (Milanovic et al., 2011; Graml et al., 2008) allow improving graphical business process modelling.

As BPMN and SBVR are based on different metamodels, Agrawal (2011) has proposed to extend SBVR metamodel to express business process vocabularies, but such changes to SBVR metamodel could cause problems for maintaining these changes in future. Therefore, using the supplementary mapping data between two metamodels was proposed in (Skersys et al., 2012). Semi-automated business vocabularies extraction from business process models was proposed (Skersys et al., 2013), however, it does not include business rules.

Automated method of BPMN business process model to SBVR transformation (Malik et al., 2012; Malik et al., 2013) was presented with a tool implementation. The method covers just a few BPMN elements. A bottom-up approach was presented by Cheng et al. (Cheng et al., 2011). Generation a natural language text from BPMN business process models (Leopold et al., 2012) in order to validate business process has shown that this method requires sophisticated linguistic processing techniques and does not guarantee completeness and reliability. The reverse approach was presented by Friedrich et al. (Friedrich et al., 2011). These methods do not allow to link elements from two different modelling approaches.

Summarizing the analysed works, it is possible to conclude that the solution to the revealed problem yet does not exist, and efforts are required for better

alignment modelling of business processes and business rules with business vocabularies and business language understandable for business participants.

5 METHODOLOGY

The current research is based on the methodology of design science research adopted by Hevner et al. to the field of Information Systems (Hevner et al. 2004). According to this methodology, new artefacts – methodology and transformations between BPMN business process models and SBVR business vovabulary and business rules will be created. The relevance of research for solving business problems and its validity regarding existing state of the art were preliminary justified by analysing related research literature, modelling languages and tools. Experimental evaluation of the implemented transformations will be carried out to validate its correctness and applicability for the intended purpose. The research will add new knowledge by answering formulated research questions, which have a practical significance for business participants, experts and modellers, and information system developers.

The research is related with the BPMN (Business Process Modelling Notation) (OMG, 2013a) – the graphical notation that allows to model business process models in a procedural way and is developed by OMG (Object Management Group). The SBVR (Semantics of Business Vocabulary and Business Rules) (OMG, 2008; OMG, 2013b) has given the most sophisticated formal knowledge model for defining business vocabularies and business rules. These two modelling approaches were selected due to the recommendation of Zur Muehlen and Indulska (2009) that the best representation power of business processes and business rules is given by combination of BPMN with SBVR. The integration and transformation between BPMN process models and SBVR business vocabulary and business rules is based on SBVR profile (Mickeviciute et al., 2014a), which can be implemented in UML CASE tools (currently, in CASE tool MagicDraw). Using the profile alows extension of SBVR metamodel without changing its original specification.

6 EXPECTED OUTCOME

The expected outcome of this research is the methodology that allows modelling BPMN business processes and business rules on the base of SBVR business vocabulary, and transformation between BPMN business process models and SBVR business vocabulary and business rules. These capabilities will be available in CASE tool MagicDraw using SBVR Profile.

7 COMBINATION OF BUSINESS PROCESS AND BUSINESS VOCABULARY AND RULES

In this section we present the approach to integrate BPMN with SBVR, the examples of BPMN to SBVR transformation rules, a fragment of BPMN process model, and an example of transformation rules implemented in QVT transformation language.

7.1 The Analysis of Research Questions

The answer to the 1st research question "How to make the right separation between graphical business process models and textual business rules models" was found on the base of analysis of related works. Shortly, the answer is "to separate process rules, initiating the process flow, from business constraint rules, allowing or preventing execution of activities, required by process flow rules".

For finding the answer to the 2nd research question "Is it possible to represent all business rules related with modelling BPMN processes by using standard SBVR vocabulary without extensions", the representative example of BPMN process was created, typical situations were analysed and transformation rules for all transformations were tried to define. The conclusion was made that it is possible to represent all business rules related with a single BPMN process but there is no possibilities to represent a process hierarchy; also, transformation rules are quite complex, especially the reverse transformation from SBVR business rules, representing complex business process elements, e.g., gates; it is impossible to identify activity types, etc.

In order to obtain the complete set of business rules representing complex hierarchical BPMN process, the BPMN metamodel vocabulary was proposed, which can be used for representing BPMN concept types in SBVR business process vocabulary and process rules. The BPMN metamodel vocabulary allows explicitly represent process structure and such complex elements as gates. The

specification of BPMN process vocabulary and process rules as well as transformation between BPMN and SBVR models becomes straightforward with the usage of BPMN metamodel vocabulary. However, BPMN process vocabulary and rules may seem unconventional and even cumbersome for business participants. Therefore, the priority is given to standard SBVR vocabulary and rules though it is limited to the scope of a single BPMN process.

The performed analysis also gave the answer to the 3rd research question "How to precisely relate business vocabulary with business process elements without applying linguistic analysis, which is appropriate to avoid". For reaching this criterion, two requirements were formulated for modelling BPMN processes: 1) strict naming rules for BPMN elements for aligning them with business vocabulary; 2) using pools and lanes in process models as otherwise it would be impossible specifying verb concepts (Mickeviciute et al., 2014b).

The 4th research question "Is it possible to define and implement reversible and lossless transformations between BPMN business process models and SBVR business vocabulary and business rules" will be answered after implementation and experimental investigation of BPMN and SBVR transformations, which currently are defined and partially implemented MagicDraw CASE tool using SBVR profile and QVT transformation language.

7.2 BPMN Process Example for Investigating BPMN and SBVR Transformation

To test this approach, we have created EU Rent BPMN business process model based on EU Rent business rules presented in SBVR specification (OMG, 2008). The fragments of the overall process are presented in Figures 1 and 2.

Figure 1 represents the highest level of EU Rent BPMN business process model. The subprocess "book car", represented in Figure 2, shows all actions that are needed a client to book a car from a branch. The model is related with SBVR business vocabulary, created using SBVR Profile (Mickeviciute et al., 2014a), based on the SBVR specification (OMG, 2013). The implementation of the SBVR profile is based on the DSL engine of UML CASE tool MagicDraw.

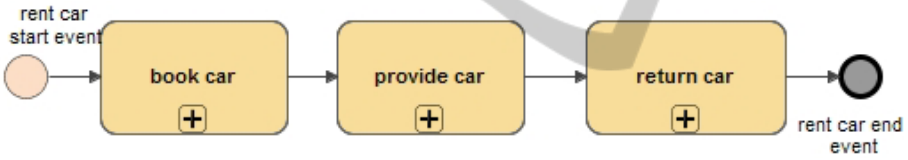

Figure 1: BPMN business process "rent car".

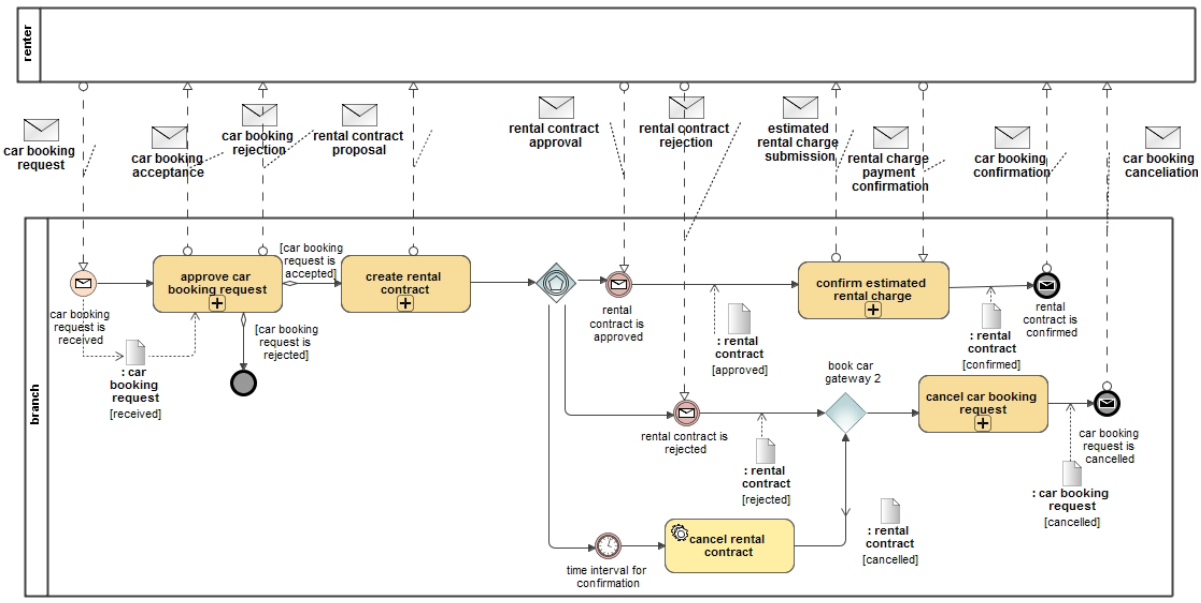

Figure 2: BPMN subprocess "book car".

7.3 Transformation Rules and Their Implementation with QVT

In order to perform BPMN to SBVR transformation, transformation rules were created. These rules were grouped into 6 groups: BPMN elements to SBVR general concepts; BPMN elements or their combinations to verb concepts; BPMN combinations of elements to SBVR business rules, which were divided into four groups due to the target or initiator of the rule: event, activity, message flow and data object. The example of a transformation rule from the first group is shown in Figure 3. The goal of this transformation is to extract SBVR general concept from BPMN message.

BPMN Message → SBVR General Concept
T_2: *transform(BPM, message: Message) → SBVR General Concept*
e.g.:
transform(BPM, 'rental contract proposal') →
rental contract proposal

Figure 3: Transformation rule from BPMN message to SBVR general concept.

The example of a transformation rule from the second group is shown in Figure 4. The goal of this transformation is to extract the SBVR verb concept from BPMN activity and pool or lane.

BPMN Activity → SBVR Verb Concept
T_9: *transform(BPM, pool|lane: Pool|Lane, activity: Activity)→ SBVR Verb Concept*
e.g.:
transform(BPM, 'branch', 'approve car booking request')→
branch *approve* car booking request

Figure 4: Transformation rule from BPMN activity and container to SBVR verb concept.

The example of a transformation rule from the third-sixth groups is shown in Figure 5. The goal of this transformation is to extract SBVR business rule from elements combination of BPMN pool or lane and two activities that are associated with sequence flow.

To implement transformation rules, the QVT transformation language was chosen, which is developed by OMG group. The example of transformation rule (Figure 3), implemented using QVT, is shown in Figure 6.

Activity1 initiates Activity2
T_{27}: *transform(BPM, pool|lane: Pool|Lane, activity$_1$: Activity$_1$, sequence_flow(activity$_1$, activity$_2$): SequenceFlow, activity$_2$: Activity$_2$) → SBVR Business Rule*
e.g.: transform(BPM, 'branch', 'schedule pick up date time', sequence_flow('schedule pick up date time','schedule return date time'), 'schedule return date time')→
It is obligatory that branch *schedule* return_date_time if branch *schedule* pick_up_date_time

Figure 5: Transformation rule from BPMN pool or lane and two associated activities to SBVR business rule.

```
mapping
CentralBufferNode::Message2GeneralConcep
t() : Class
when { self.isStereotypedBy('Common',
'Message') } -- mapping guard
{var ste : Stereotype :=
prof.objectsOfType(Stereotype)![name =
"general concept"];
-- (2) Mapping result must be part of
the model before stereotype application.
this.modelis.ownedType += result;
-- (3) Stereotype application on the
resulting Class element.
  result.applyStereotype(ste);
  name:= getNameWithNoSpace(self.name);
}
```

Figure 6: QVT code to transform BPMN element message to SBVR general concept.

8 CONCLUSIONS AND FUTURE WORKS

Analysis of related works has shown that the problem of modelling business processes and business rules in CASE tool environment, related with business vocabulary, is one of the most important challenges for business analysts and information system developers. This problem has interested scientists and practitioners, especially for integrating for this purpose the BPMN and SBVR models. The main research questions were investigated:

– For making the right separation between graphical business process models and textual business rules, the solution was to separate process rules, initiating the process flow, from business

constraint rules, allowing or preventing execution of activities, required by process flow rules.

For analysing possibility to represent all business rules related with modelling BPMN processes by using standard SBVR vocabulary without extensions, the representative example of EU Rent BPMN process was created, typical situations were analysed and transformation rules for all transformations were defined. The conclusion was made that it is possible to represent all business rules related with a single BPMN process but there is no possibilities to represent a process hierarchy; also, transformation rules are quite complex, especially the reverse transformation from SBVR business rules, representing complex business process elements, e.g., gates; it is impossible to identify activity types, etc. The solution for representing the complete BPMN processes, the BPMN metamodel vocabulary was proposed for extending SBVR metamodel without changing its original specification.

For precisely relating business vocabulary with business process elements without applying linguistic analysis, which is appropriate to avoid, two requirements were formulated for modelling BPMN processes: 1) strict naming rules for BPMN elements for aligning them with business vocabulary; 2) using pools and lanes in process models as otherwise it would be impossible specifying verb concepts (Mickeviciute et al., 2014b).

The possibility to implement reversible and lossless transformations between BPMN business process models and SBVR business vocabulary and business rules will be investigated via experiments after implementation of BPMN and SBVR transformations, which currently are defined and partially implemented in MagicDraw CASE tool using created SBVR profile and QVT transformation language.

The research will give the new knowledge and the tool prototype, which have a practical significance for business participants, experts and modellers, and information system developers.

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