Automated transformation of Business Rules into Business Processes
From SBVR to BPMN

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Abstract—this paper presents a novel approach for transforming Business Rules expressed with Semantic of Business Vocabulary and Rules (SBVR) into (BPMN) Business Process models. This transformation provides several benefits to Information System project stakeholders, such as: enhancing requirement validation and refinement, improving Business Processes documentation, and reducing their overall modeling effort. To bridge the gap between SBVR and BPMN, we propose novel transformation rules that cover structural and behavioral SBVR rules. We illustrate and discuss our transformations with the EU-Rent case study, provided in the OMG specification.

Keywords- Business Rules; Semantic of Business Vocabulary and Rules (SBVR); Business Process Model and Notation (BPMN); Model Driven Architecture (MDA).

I. INTRODUCTION


However, the current version BPMN 2.0 ¹ provides a sophisticated notation that could be quite complex for business experts. Feuto et al. [5] stress that business experts usually use Business Rules (BRs) to express their business needs. BRs specify the semantics of the business objects involved in business activities, the constraints (precondition/post condition) on these activities, the reactions to events, as well as the actor’s rights and responsibilities in a BP [2].

To facilitate communication between business and IT experts, the Object Management Group have proposed Semantic of Business Vocabulary and Rules (SBVR) specification [2]. This standard offers a meta model for documenting the semantics of business domain concepts and business rules, in an unambiguous and understandable way to humans as well as computer systems (as SBVR is grounded on first order and modal logic [2]).

Since SBVR and BPMN are fully integrated in the MDA approach and behave as Computer Independent Model (CIM), we advocate that model to model transformation [3] could offer an interesting solution to bridge the gap between business and IT experts. Thus, instead of using BPs models as a requirement validation mean, we could use BRs natural language specification to communicate with business expert and then run transformations to generate the corresponding BP models.

The main objective of this paper is to introduce a transformation methodology from SBVR meta model to BPMN Meta model, in order to ease the communication and the requirement validation step in BPM projects.

Different strategies were used in the literature to address the relationships between Business Rules and Business Processes [7][8][9][10]. However, few works have focused on the automated transformation from SBVR to BPMN, without significant alteration of their original concepts.

A. Raj et al. [11], Z. Wu et al. [13], Roover et al. [14], and B.Steen et al.[12] focus on behavioral aspects of BPs and neglect organizational and informational aspects [15]. Therefore, in this paper we address a more comprehensive coverage of SBVR Business Rules (i.e. structural and operative rules [2]) in order to generate more accurate BPs models. To this end, we have refined the above mentioned transformations and we have formalized basic ideas discussed in [2] [16] and [17] in our transformation methodology.

The remainder of this paper is structured as follows. Section II summarizes SBVR and BPMN meta models. Section III presents and illustrates the new transformation rules from SBVR to BPMN with excerpts from the EU-RENT case study [2]. Section IV is devoted to the conclusion and presents future research directions.

II. BACKGROUND: SBVR AND BPMN METAMODELS

This section summarizes the main SBVR and BPMN meta model elements that were used in our transformation approach.

A. Semantic of Business Vocabulary and Rules (SBVR)[2]

The SBVR meta model is organized into two main elements:

¹ http://www.bpmn.de/images/BPMN2_0_Poster_EN.pdf
1) **Business vocabulary:** composed of noun concepts and verb concepts (fact types) used by a community or an organization.

2) **Business rules:** Define the structure and the constraints on the business vocabulary. They are specialized into structural and operatives rules. The formers are definitional rules and express the claims of necessity (alethic modality). The later are related to business behavior (deontic modality).

The specification also offers an English vocabulary for describing vocabularies and stating rules called SBVR Structured English. It is based on the use of font styles and there are of four formatting styles as follows: An object type is represented in underlined green, an individual concept is represented double underlined green, a fact type is represented in italics blue and keywords (cf. 2.semiotic formulation) are represented in red. Example: behavior rule: obligation: Each order must be processed within one business day.

SBVR specification offers a way to expresses the logical composition rules [2] called Semantic Formulation. Semantic formulations are specialized into logical formulation and projection. In this paper, we use logical formulation to structure business rules; the projections were used in the literature to express questions, to formalize SPARQL queries [18]. We focus on the five logical formulations that may structure BPs models, namely:

- **Atomic formulation** which refers to propositions that are based on exactly one fact type. (example: EU-Rent purchases from General Motors Company).

- **Modal formulation** which is a Logical formulation that formulates the meaning of another logical formulation. Each modal formulation embeds exactly one logical formulation. Modal formulations are further specialized into necessity, obligation, possibility and permissibility. The SBVR specification provides a set of keywords referring to these modalities. (example: It is prohibited that a rental is open if an estimated rental charge is not provisionally charged for the rental).

- **Quantification:** introduces and constrains a variable in logical formulations, such as: existential quantification

- **Instantiation formulation** which refers to proposition that is based on exactly one fact type and that embeds individual concepts. (example: EU-Rent is a car rental company)

- **Logical operation** which refers to proposition that are based on one or many fact types. These fact types may formulate negation, conjunctions, disjunctions, implication, nor, and wether or not formulations.

Figure. 1 shows an excerpt of the SBVR meta model [2].

![Figure 1. SBVR Meta model excerpt](image)

**B. Business Process Model and Notation (BPMN)**

We use the current version BPMN2.0 [1] as a target meta model of our transformation approach. The BPMN meta model is depicted in figure 2. A BPMN process model is a graph consisting of four types of elements.

- **Flow objects:** consisting of activities, gateway and events

- **Connecting objects:** Allow flow objects connections and are further specialized into: sequence flows, default flows, conditional flows, message flows and associations.
Swimlanes: Allow flow object assignment to BPs participants. They are divided into pools and lanes (partition of pools).

Artifacts: Dataobject and textAnnotation are artifacts that represent piece of information processed in a BPs and comments on BPs respectively.

III. THE TRANSFORMATION APPROACH

A. Overview of our approach

Our ultimate aim is to define automated transformations from natural language to a BPMN model. But, in this paper, we focus on model to model transformation from a Structured English SBVR specification to a BPMN model. Text to model transformations proposed in [6] could be used as a starting point to our approach. We make the assumption that the input SBVR SE specification is consistent and complete.

Our approach is divided into two steps:

- Business vocabulary supporting fact types to BRs is transformed to BPMN core BP constructs, namely: BP participants, activities, pre/post conditions, and data objects.(cf. subsection B)
- Business Rules transformations are then applied to define the control flow of the identified core constructs, and to potentially refine them. (cf. subsection C)

B. Mapping Business Vocabulary to BPMN primitives

1) SBVR Fact Type transformation
   a) Binary fact type[11][12]

   T1: Each binary fact type is mapped to a BPMN task
   T2: Each fact type role 1/individual concept role 1 of a binary fact type is mapped to a BPMN lane
   T3: Each fact type role2/individual concept role2 of a binary fact type complements the task name of the transformation T1

   b) Binary fact mapping refinement

   T4: Each binary fact type, synonym of sends/receives terms is mapped to a BPMN send/ receive task. If the task type is sends, then we add a message flow named as the fact type role or the individual concept represented in role2.
   SBVR example: Booking clerk sends rejection
   BPMN output:

   T5: Each binary fact type, synonym of create/read/update/delete terms (CRUD) is mapped to a BPMN user task attached to data object
   SBVR example: Sales creates contract
   BPMN output:

   T6: Each is-property-of fact type is mapped to a BPMN annotation attached to a task to express a precondition/post condition
   SBVR example: Rental has at least one driver
   BPMN output:

   c) Binary fact mapping refinement

   T7: Each specialization fact type related to the identified lanes of (T2) is mapped to a BPMN Pool
   SBVR example: Sales specializes EU rent Enterprise
   BPMN output:

C. Mapping Business Rules to BPMN elements

1) Mapping Structural Business Rules
   a) Mapping integrity rules

   T8: Each unary fact type (characteristic) is mapped to:
   - Message initiating event if it belongs to the first business rule of the SBVR specification
   - Else it is mapped to an Exclusive gateway

   T9: Each structural rule expressing integrity constraint is mapped to an annotation attached to a task to express precondition/postcondition. The logical formulation type is further specialized into atomic formulation, instantiation formulation, modal formulation and logical formulation except implications formulations.
   SBVR example: A customer of the car rental company EU-Rent must be at least 25 years old
   BPMN output:
b) Mapping derivation rules

**T10:** Each derivation rule is mapped to a BPMN business rule task (BPMN 2.0 extension); the stereotype business rule is added to a previously identified task with T1 (based on underlying binary fact type of the derivation rules).

**SBVR example:** It is necessary that If customer is an enterprise, the renter (discount is calculated as 20% of the rental price). Else the renter discount is calculated as (10% of the rental price).

**BPMN output:**

NB: The enforcement of this rule simplifies the BPMN model as Business rule task replaces complex paths modeled with gateways

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2) Transforming operational Business Rules

a) Transforming Reaction rules and production rules

Except the event concept, reaction, and production rule patterns are similar.

- Reaction rule: `<event>` `<condition>` `<action>`
- Production rule: `<condition>` `<action>`

This transformation addresses the behavior view of BPMN models. It links implication formulations \(^2\) to six basic control flow patterns of BP models. T11 is an example of sequence pattern identification.

**T11:** Each implication formulation expressed as: If `<atomic formulation>` then `<atomic formulation 2>` is transformed to a sequence pattern.

**SBVR example:** if the system display the welcome-screen then the user insert the card

**BPMN output:**

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b) Transforming transforming rules

**T12:** Each operative rule expressing integrity constraint is mapped to an annotation attached to a task to express `precondition/postcondition`.

**SBVR example:** An employee’s age can change from 30 to 31, but not from 31 to 30.

**BPMN output:**

IV. CONCLUSION

In this paper, an automated approach to transform SBVR meta model to BPMN meta model is proposed. The main objective of this transformation is to assist business experts in the requirement validation phase, as BRs are expressed in natural language. Literature review has revealed that SBVR to BPMN approaches address only the behavioral view of a BP. We tried to offer a more unified view of a BP, by covering the main categories of BRs in our transformations. Future work will address validation issues in real industrial setting, prototype implementation and transformations refinement to BPMN2.0 choreographies and conversation diagrams.

REFERENCES


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\(^2\) A Business Rule Task provides a mechanism for the Process to provide input to a Business Rules Engine and to get the output of calculations that the Business Rules Engine might provide.” [1]

\(^3\) http://www.workflowpatterns.com/