SemFrameX – Towards a Framework for the Semantic Justification of BPMN Adaptations

Richard Braun

Technische Universität Dresden,
Chair of Wirtschaftsinformatik, esp. Systems Development, 01062 Dresden, Germany
richard.braun@tu-dresden.de

Abstract. In recent years numerous extensions and adaptations of the BPMN evolved, since model users aim to both exploit the benefits of the modeling standard and adapt BPMN to particular domain peculiarities or project requirements. Methodical support for conducting such adaptations is generally rare and very focused on the abstract syntax, which is actually insufficient, since particular semantics are more relevant. Consequently, it seems to be reasonable to explicitly conduct semantical analysis and comparison checks before extending or adapting BPMN. However, appropriate semantic specifications of BPMN are missing. After introducing and motivating the entire issue, we therefore outline the *SemFrameX* framework that aims to specify the BPMN meta model semantics with a special consideration of ontic, epistemological, conceptual, linguistic and pragmatics aspects.

Keywords: Semantics, Meta Modeling, Extensibility, Process Modeling, Enterprise Modeling Languages, Semantics Framework

1 Extension and Adaptation of BPMN

The Business Process Model and Notation (BPMN) constitutes a prevalent standard for modeling business processes and workflows, which are pivotal parts of enterprises [15]. The level of standardization and application in various domains and projects both in industry and academia leads inevitably to the need for situational extension or adaptation of BPMN [9] in order to enhance, augment [2, p. 51] or specify the language [8]. This implies a particular customization of the BPMN [8, p. 400], which may constitute as dialect [4,10], punctual extension [11] or even as reduced BPMN version [18]. This need for language adaptation is especially caused by the immanent diversity of single domains and enterprises, which factually precludes any *one fits all* approach [24,5]. In contrast to nearly all Enterprise Modeling Languages (EMLs [8, p. 399]) BPMN therefore explicitly provides an extension mechanism aiming to integrate additional meta model elements systematically [31, p. 43]. Further, BPMN as Purpose-Specific Modeling Language (PSML) provides concepts that are explicitly under-specified (cf. [19, p. 136]) in order to enable their specification for respective domains or problems (e.g., *Data Objects* [31, p. 203] or *Pools* [31, p. 306]). While the syntax of BPMN

C. Hochreiner, S. Schulte (Eds.): 8th ZEUS Workshop, ZEUS 2016, Vienna, Austria, 27-28 January 2016, Proceedings – published at http://ceur-ws.org/Vol-1562

is (widely [30,7]) well-defined, the issue of language adaptation is only supported to a very limited extent implicating both a lack of procedural assistance and semantics [7]. Research on BPMN adaptations merely focuses the syntax and semantic issues are only discussed occasionally [13].

We assume that this is strongly amplified by the general syntax focus of the BPMN specification, which provides only very short and limited semantic references in natural language statements [31]. This might be caused by the rather technical origin of BPMN. Further, parts of BPMN are intended to be executable [31, p. 435] implicating formal behavioral semantics [6, p. 3402], while a range of concepts have material semantics (e.g., *Manual Tasks* or *Pools*). Both types of semantics actually require different kinds of semantic specification (cf. [33]). Due to the stated issues it is difficult to conduct well-justified adaptations of BPMN, since the BPMN specification itself does not provide a solid and detailed semantic base. To the best of our knowledge there is no complete semantic analysis or description of BPMN, which provides respective semantic domain concepts and mappings. Existing research works are either not very mature [13], focus syntactical aspects [30,36] or address only the model layer but not the meta model layer [29]. However, imprecise or even missing semantic specification of EMLs is a general issue that is under-investigated [21, p. 485], [1, p. 108], although semantics seem to be an extremely promising language driver (cf. [4]).

This paper therefore aims to bring light into the dark of semantic specifications in BPMN. Therefore, the semantic issue of BPMN is stated in Section 2. Section 3 then motivates the *semantics first* approach and outlines the *SemFrameX* framework by introducing its dimensions. The paper ends with a short outlook in Section 4.

2 Issues with Semantics

Several authors criticize the lack of semantic specifications in EMLs and emphasize their importance [20, pp. 67-69], [37, pp. 690, 706]. But despite several approaches (e.g., [22,32,26]) no accepted and prevalent standard evolved so far and also the explication of required modeling concepts is still rudimental [19,16]. Instead, both the design of EMLs and EML extensions strongly focus the syntax perspective, while semantics and pragmatics are more or less ignored [4]. In the context of BPMN, we assume that the following reasons may cause the unsatisfying struggles with semantics.

Awareness of relevant parts: There is a lack of consensus about those parts, which determine semantics. The specification of semantics is rather diffuse and remains mostly informal. It is therefore advised to take an integrated view on semantics in regard of the meta model constructs itself as well as the used textual elements.

Formal and material semantics: In contrast to formal domains in the field of Computer Science (CS) [17], the domain of enterprises and business process cannot be completely formalized (material semantics [33]). However, some tasks or purposes require the definition of formal specifications (formal semantics

[17,6]). Respective differences and also integration points should be investigated (hybrid semantics [12]).

Ambiguity: Enterprises are complex socio-technical information systems affecting several aspects – both real-world things and artificial things [26]. This underlines the importance of subjective interpretation depending on personal experiences, cognition and mental conceptualization [27], which is especially relevant within collaborative process modeling in order to avoid misunderstandings, for instance. It is hence necessary to take ontic and epistemological issues into account in order to become aware of its impact and respective consequences for language design and language application.

Multiple research fields: The investigation of semantics is an essential topic in philosophy and cognition research that addresses fundamental epistemological questions. In the CS community, semantics is relevant in the field of Information Retrieval or Semantic Web, for instance. Both areas seem to be relevant in the Information Systems (IS) discipline. However, integration is not trivial due to differing semantic understandings (cf. [38,20]).

3 SemFrameX - Integrated Framework Approach

3.1 Semantically Driven Justification of BPMN Adaptations

It becomes obvious that semantics are crucial in the context of BPMN and also indispensable for BPMN adaptation. We therefore argue that all adaptations should follow a *semantics first* approach in the sense of the following two parts:

Explication of the expected semantics: First, the expected semantics in the sense of required domain concepts should be explicated in order to express objectives and requirements [35,13,16]. The expected semantics are closely coupled with the underlying pragmatic intention [4]. For instance, if the user just aims to document particular real-world aspects then material semantics are applicable (e.g., [2]). If the user intends to enhance BPMN for some automation tasks then formal semantics might become relevant (e.g., [6]). Also *hybrid semantics* as combination of both aspects is imaginable (e.g., in case of clinical decision systems, where supporting processes need to be automated [12]).

Justification of EML adaptation: Afterwards it is necessary to compare the expressiveness of BPMN with the required expressiveness of a particular situation in order to justify and elaborate the need for adaptation based on semantic correspondence checks [1, p. 100]. The comparison finally leads to respective syntactical constructs [13] and might determine the type of extension (e.g., a profile-based BPMN dialect [10]).

3.2 Framework Architecture

As stated in Section 1, semantics in the Enterprise Modeling (EM) context are multi-faceted, not trivial and little considered in literature so far. We therefore aim to tackle the issue by analyzing several dimensions in regard of semantics,

which constitutes as the *SemFrameX*[1] framework that is presented in Figure 1. With respect to the limited space of this paper, the architecture is introduced by a brief presentation of the single dimensions.

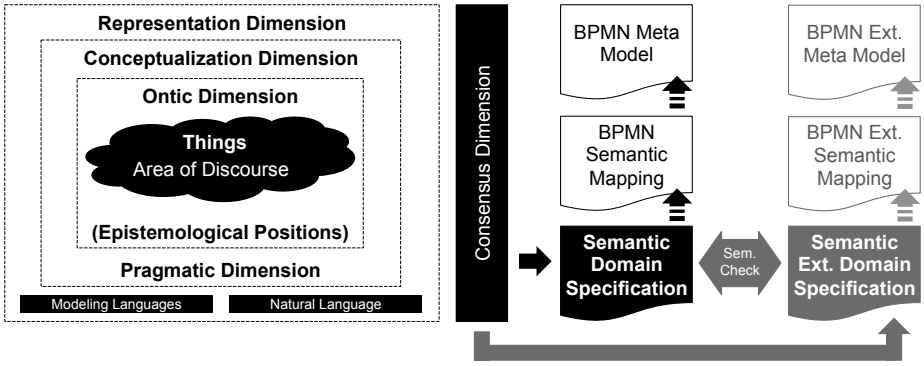

Fig. 1. The *SemFrameX* framework for the multi-faceted specification of meta model semantics and its relevance for language extension.

3.3 Ontic Dimension and Epistemological Position

Fundamentally, any semantic consideration finally leads to an analysis of those *things* that are somehow referred by symbols of a language [39]. It is therefore necessary to analyze and categorize different types of things, e.g. material things or artificial things [26]. As we consider the meta model layer, a thing itself is understood as an already abstracted *class of things* with common features within a particular area of discourse. Hence we consider an implicit abstraction step of modelers, which have to be inferred from single, detectable entities to a class of those entities. More precisely, the fundamental type of respective classes of things in regard of their actual existence in reality (realism vs. idealism) as well as their perception (objectively perceptible vs. subjectively perceptible) have to be considered (adapted from [14,3]). This categorization is important for contingent epistemological positions like Positivism, Critical Rationalism, Radical Constructivism or Methodic Constructivism. Those positions largely determine respective theories of truth, which are especially relevant for the differentiation between formal and material semantics [33] as well as for the identification of differences between conceptualizations of things [25].

[1] *SemFrame* stands for *semantic framework*, while the suffix *X* emphasizes its relevance for extensions and adaptations.

3.4 Conceptualization Dimension

Conceptualization is understood as the individual understanding of the stated class of things. This conceptualization is a central point of analysis, as it depends on the personal understanding of a particular meta model and finally refers to some things s/he has in mind. The only exception is represented by a class of things that is perceived as real and objectively perceptible (Positivism). In each other constellation, the conceptualization is strongly subject-dependent and can cause variant interpretations of meta model constructs by interpreting them differently, for instance [27].

3.5 Pragmatic Dimension

Generally, the application context determines the expected capabilities of a modeling language [38, p. 5] and the concrete modeling purpose plays an immanent role within conceptualization [4, p. 436]. Some authors state that the real meaning of a language finally results from its factual usage [4, p. 438], serving a particular utility [35]. Hence, the underlying or intended pragmatics also influence the aimed semantics. If BPMN is intended to be used for pure documentation then material semantics are relevant, causing a descriptive mode of the semantics (cf. [1]). In contrast, BPMN can be also used to describe (at least partly) automatable processes or message exchange services, which rather cause formal semantics and represent a normative or prescriptive character.

3.6 Representation Dimension

Conceptualizations and things (in case of Positivism) need to be explicated in any form. Ontologies are often proclaimed as means for semantic annotations [22,23]. Basically, even those rather minimalistic languages have a certain syntax and semantics, which have to be taken into account. Further, also the semantics of the meta modeling language used to design the BPMN meta model has to be considered, as it refers indirectly to some artificial things of constructs (e.g., *Generalizations*). These aspects are covered by the framework element *modeling language*. In addition, *natural language* emphasizes the importance of single words (sememe) as basic source of ambiguity. While structural issues are covered by the above mentioned dimensions, natural language based ambiguity is actually the most important issue, since all the stated problems finally lead to lexical topics like synonym and homonym conflicts [34]. For instance, further research on other lexical types like hypernyms, hyponyms, meronyms, holonyms, antonyms and troponyms is needed [22, p. 1628], [38, p. 8], [28, p. 89].

3.7 Consensus Dimension

Despite divergence and ambiguity, it is important to find a particular consensus on semantics in the sense of an agreement of different personal conceptualizations in order to provide an applicable language within a language community. Although

Consensus Theory of Truth is usually applied in Constructivism and Critical Rationalism, we suggest its consequent application, since process modeling usually covers at least some things that are not invariant interpretable. After finding a particular consensus on the semantic specification of either the entire BPMN or prospective BPMN extensions, semantic comparison techniques can be applied in order to justify extension or adaptation need (right side in Figure 1). Currently, we intend to conduct specific ontological comparisons based on generic enterprise ontologies and domain-specific ontologies for this task.

4 Conclusion

This paper presents an overview of a research-in-progress project aiming to elaborate an integrated and multi-faceted semantic description technique for BPMN based on an analysis of ontic and epistemological aspects. The integrated semantic description of BPMN elements should facilitate the justification of potential BPMN extensions or adaptations. Further, the aimed semantic description technique should support the specification of respective requirements profiles, which are the base for comparison with semantics of BPMN. The initial architecture of the *SemFrameX* framework is outlined and its dimensions are briefly introduced.

Further research is manifold, as each dimension has to be investigated in detail. We therefore aim to start with the core of the framework by characterizing and classifying different types of things and respective consequences for their interpretation (formal or material semantics). This is closely related to current investigations in the field of hybrid semantics aiming to specify and integrate both types in BPMN and support the derivation of BPMN extensions and dialects. Furthermore, an inductive application of the proposed architecture to other EMLs seems to be promising.

Acknowledgement: This paper presents results from the research project *SFB Transregio 96*, which is funded by the German Research Foundation (DFG). The author further appreciates the helpful reviewer comments on this paper.

References

1. Anaya, V., Berio, G., Harzallah, M., Heymans, P., Matulevičius, R., Opdahl, A.L., Panetto, H., Verdecho, M.J.: The unified enterprise modelling language – overview and further work. Computers in Industry 61(2), 99–111 (2010)
2. Atkinson, C., Gerbig, R., Fritzsche, M.: Modeling language extension in the enterprise systems domain. In: Proceedings of the 17th IEEE EDOC. pp. 49–58 (2013)
3. Becker, J., Holten, R., Knackstedt, R., Niehaves, B.: Wissenschaftstheoretische grundlagen und ihre rolle für eine konsensorientierte informationsmodellierung pp. 307–334 (2003)
4. Bjekovic, M., Proper, H.A., Sottet, J.S.: Embracing pragmatics. In: Conceptual Modeling. LNCS, vol. 8824, pp. 431–444 (2014)

5. Bjekovic, M., Proper, H.A., Sottet, J.S.: Enterprise modelling languages – just enough standardisation? In: Business Modeling and Software Design. LNBIP, vol. 173, pp. 1–23 (2013)
6. Bork, D., Fill, H.G.: Formal aspects of enterprise modeling methods: A comparison framework. In: Proceedings of the 47th HICSS. pp. 3400–3409 (2014)
7. Braun, R.: Behind the scenes of the bpmn extension mechanism - principles, problems and options for improvement. In: Proc. of the 3rd MODELSWARD. pp. 403–410 (2015)
8. Braun, R.: Towards the state of the art of extending enterprise modeling languages. In: Proc. of the 3rd MODELSWARD. pp. 394–402 (2015)
9. Braun, R., Esswein, W.: Classification of domain-specific bpmn extensions. In: The Practice of Enterprise Modeling. LNBIP, vol. 147, pp. 42–57 (2014)
10. Braun, R., Esswein, W.: Designing dialects of enterprise modeling languages with the profiling technique. In: Proceedings of the 19th IEEE EDOC. pp. 60–67 (2015)
11. Braun, R., Esswein, W.: Extending the mof for the adaptation of hooks, aspects, plug-ins and add-ons. In: Model and Data Engineering. pp. 28–38. LNCS (2015)
12. Braun, R., Esswein, W.: Towards hybrid semantics of enterprise modeling languages. In: Proc. of the 4th MODELSWARD (2016)
13. Braun, R., Schlieter, H.: Requirements-based development of bpmn extensions: The case of clinical pathways. In: IEEE 1st RE-BPMN. pp. 39–44 (2014)
14. Braun, R., Esswein, W.: Eine methode zur konzeption von forschungsdesigns in der konzeptuellen modellierungsforschung. In: Data Warehousing. pp. 143–172 (2006)
15. Chinosi, M., Trombetta, A.: Bpmn: An introduction to the standard. Computer Standards & Interfaces 34(1), 124–134 (2012)
16. De Kinderen, S., Ma, Q.: Requirements engineering for the design of conceptual modeling languages - a goal-and value-oriented approach. Applied Ontology (2015)
17. Engels, G., Hausmann, J.H., Heckel, R., Sauer, S.: Dynamic meta modeling: A graphical approach to the operational semantics of behavioral diagrams in uml. In: UML 2000 – The Unified Modeling Language, pp. 323–337. Springer (2000)
18. Fernández, H.F., Palacios-González, E., García-Díaz, V., G-Bustelo, B.C.P., Martínez, O.S., Lovelle, J.M.C.: Sbpmn – an easier business process modeling notation for business users. Computer Standards & Interfaces 32(1), 18–28 (2010)
19. Frank, U.: Domain-specific modeling languages: requirements analysis and design guidelines. In: Domain Engineering, pp. 133–157. Springer (2013)
20. Harel, D., Rumpe, B.: Meaningful modeling: what's the semantics of semantics? Computer 37(10), 64–72 (2004)
21. Harzallah, M., Berio, G., Opdahl, A.L.: New perspectives in ontological analysis: Guidelines and rules for incorporating modelling languages into ueml. Information Systems 37(5), 484–507 (2012)
22. Höfferer, P.: Achieving business process model interoperability using metamodels and ontologies. In: Proceedings of the 15th ECIS. pp. 1620–1631 (2007)
23. Kaczmarek, M.: Categories of ontologies' applications in the realm of enterprise modeling. In: Proceedings of IEEE 17th CBI. vol. 1, pp. 98–107 (2015)
24. de Kinderen, S., Ma, Q., Proper, H.A.: Model bundling: Towards a value-based componential approach for language engineering. In: Proceedings of the 8th VMBO (2014)
25. van der Linden, D., Hoppenbrouwers, S.: Challenges of identifying communities with shared semantics in enterprise modeling. In: The Practice of Enterprise Modeling. LNBIP, vol. 134, pp. 160–171 (2012)
26. van der Linden, D., van Zee, M.: On the semantic feature structure of modeling concepts: an empirical study. In: Proc. IEEE 16th CBI. pp. 158–165. IEEE (2014)

27. van der Linden, D.: Personal semantics of meta-concepts in conceptual modeling languages. Ph.D. thesis, Radboud University Nijmegen (2015)
28. Mendling, J., Leopold, H., Pittke, F.: 25 challenges of semantic process modeling. IJISEBC 1(1), 78–94 (2014)
29. Mickevičiūtė, E., Butleris, R.: Towards the combination of bpmn process models with sbvr business vocabularies and rules. In: Information and Software Technologies, pp. 114–121. Springer (2013)
30. Natschläger, C.: Towards a bpmn 2.0 ontology. In: Business Process Model and Notation, pp. 1–15. Springer (2011)
31. OMG: Business Process Model and Notation (BPMN) - Version 2.0. Object Management Group (OMG) (2011)
32. Opdahl, A.L.: Anatomy of the unified enterprise modelling ontology. In: Enterprise Interoperability, pp. 163–176. Springer (2011)
33. Pfeiffer, D., Gehlert, A.: A framework for comparing conceptual models. In: Proceedings EMISA. pp. 108–122 (2005)
34. Pittke, F., Leopold, H., Mendling, J.: Automatic detection and resolution of lexical ambiguity in process models. IEEE Trans. on Soft. Eng. 41(6), 526–544 (2015)
35. Proper, H.A., Verrijn-Stuart, A.A., Hoppenbrouwers, S.: On utility-based selection of architecture-modelling concepts. In: Proc. of the 2nd APCCM. pp. 25–34 (2005)
36. Rospocher, M., Ghidini, C., Serafini, L.: An ontology for the business process modelling notation. In: Formal Ontology in Information Systems - Proceedings of the 8th FOIS. vol. 267, pp. 133–146. IOS Press (2014)
37. Santos, P.S., Almeida, J.P.A., Guizzardi, G.: An ontology-based analysis and semantics for organizational structure modeling in the aris method. Information Systems 38(5), 690–708 (2013)
38. Thalheim, B.: Syntax, semantics and pragmatics of conceptual modelling. In: Natural Language Processing and Information Systems, pp. 1–10. Springer (2012)
39. Ullmann, S.: Semantics: An introduction to the science of meaning (1979)