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Business Process Web-based Platform for Multi modeling and Simulation

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Abstract:

Enterprises and organizations need more streamlined business processes (BPs) to increase their performance. One of the main factors in building successful BPs is the stakeholders' engagement in BP management and improvement projects via modeling and simulation methodologies, which aspires to reduce conflicts, encourage innovation, and increase ownership and inclusive decision making. This paper attempts to highlight the existing development of concepts, methods, and tools bridging the gap between the business process modeling and simulation worlds. This paper will summarize current works and propose perspectives about a transformation approach of Business Process Modeling and Notation (BPMN) models that are extended with Business Process Simulation Interchange Standard (BPSIM) into Discrete Event System Specification (DEVS) simulation models based on a metamodel approach.

Keywords:

Model-Driven Engineering (MDE), Business Process Modeling and Notation (BPMN), discrete event simulation (DES), Discrete Event System Specification (DEVS), Model Transformation, Meta-Modeling, Business Process Simulation Interchange standard (BPSIM)

1 INTRODUCTION

Business process management is widely deployed and used in many organizations, and business processes are a significant part of the organization's running. It is used on three levels - first at a descriptive level to share and capitalize knowledge; second at an executable level to orchestrate and automate business processes; and third at an analysis level to improve performance. To this purpose, BPMN language is becoming an in-demand skill in the business industry [14]. BPMN workflows are usually designed by business users or developers using standalone applications allowing stakeholders to translate their knowledge into

conceptual models away from development, implementation, and environments. On the other hand, business process simulation is an essential element for the performance optimization of organizations [10]. Although very important in business process management, simulation is still not systematically used in most business process improvement projects. One reason could be that simulation usually requires additional acquired techniques performed by technical users rather than the business stakeholders. Models can bring added-value support in the design of complex systems. Many large industries adopt the Model-Driven Engineering (MDE) approach in developing complex systems. It has proven its efficiency in various business domains such as aerospace, automobile, telecommunications, etc. [18]. MDE concentrates on the source model conformity to a defined metamodel. The source model is then transformed into a target model following mapping rules and transformation techniques. In modeling extensive processes, business stakeholders collaborate to share their knowledge in defining the business process. Modeling and Simulation (M&S) methodologies recommend using conceptual models during the simulation model development process, which requires engaging business stakeholders in discrete event simulation improvement projects [5]. The purpose of this paper is to allow us to extend BPMN workflows using discrete-event simulation elements specified in BPSIM; the extended model will be transformed into a DEVS model to operate the

simulation. The paper is structured as follows. After a brief introduction in section 1, problems and expected outcomes are presented in section 2. Community contribution is detailed in sections 3,4,5. Our proposition is presented in section 6 (extension and transformation approach). Section 7 concludes the paper and opens outlines.

2 PROBLEMS AND EXPECTED OUTCOME

Enterprise business processes need to be formalized to be better understood and monitored. For this purpose, several standards have been developed. This paper will specifically study BPMN, a standard set by the Object Management Group (OMG) that provides a conventional notation allowing collaboration between business users, analysts, and implementers. BPMN is currently mature with over 20 years of use and development and widely expresses business processes. Several business process tools integrate graphical notation and software and are able to interpret process models in order to orchestrate them. However, these tools are limited in operational simulation capabilities [12]. Selected free and open-source BPMN applications exist, which business stakeholders may use to design business processes. Such tools may allow model simulation but integrating the modeling part with the simulation part is still not comprehensive. For example, external simulation elements (scenario parameters, resources, duration, etc.) need to be added to the model to be simulated. Therefore, these two worlds remain separate, limiting the use of simulation to users accustomed to simulation principles. On the other hand, BPSIM is a standardized specification developed to simulate business models by enriching the conceptual model with scenario parameters that affect the process execution [17]. BPSIM aims to enrich selected BPMN elements with information on related parameters and logic significant for the simulation model. This paper discusses the transformation and simulation of a BPMN mo-

del extended with BPSIM into a simulation model that conforms to the DEVS formalism to permit verification and simulation of the model properties. Consequently, we intend to develop a web-based platform to empower business stakeholders and engage them in discrete event simulations and business process improvement projects.

3 BPMN & ITS EXTENSION

BPMN is a business process modeling method used to describe an organization's value chains and business activities using a graphical representation (ISO/IEC 195103 [12]). The model extension is a technique that supports the enrichment of the model with external concepts originating from different domains. Extensibility is one of the main features of the BPMN metamodel as defined by OMG. BPMN extensions are utilized to visualize elements not available in BPMN like resources [16] or key performance indicators [13]. On the other hand, resource allocation mechanisms and failure of resources are represented as BPMN extensions in the context of discrete event simulation. BPMN extensions are divided into conceptual enrichment and operational enrichment. The conceptual enrichment includes the extensions of resources by adding attributes like resource description, nature, and capacity. The operational enrichment consists of describing the behavior of the enriched element. For example, tasks may be extended in order to describe the interoperability behavior [8]. BPMN users may enrich a specific metamodel by adding extension elements and attaching additional attributes to existing BPMN elements, and the model would remain BPMN-Compliant [12].

4 BPMN TRANSFORMATION & SIMULATION

MDE is a software engineering methodology that promotes the development of models at different levels of abstraction, raising the level of development to models rather than pro-

grams. The core principles of MDE are the use of models and model transformation. The principle of the models concentrates on the notion of meta-model and conformance, while the principle of model transformation includes the concept of mappings and transformation rules [9]. The transformation of high-level workflows into simulation models was a main area of study by many researchers in the last two decades. In the context of MDE and metamodel based transformation, both source and target models must conform to their respective metamodel. While BPMN conforms to the BPMN metamodel standardized by OMG [12], simulation models like DEVS do not have a specific standardized metamodel yet researchers worked to define a model-driven development framework for M&S. Such framework presented BPMN and DEVS metamodels and a defined set of rules to transform a conceptual source model BPMN into a simulation model DEVS [3]. BPMN elements differ in their internal behavior. These elements may be considered black boxes compared to white boxes DEVS models. To simulate a BPMN flow in DEVS, elements of this flow need to be mapped to their corresponding DEVS representation. Over the past years, researchers worked on providing a mapping for different BPMN elements. However, only a few elements were studied and taken into consideration. Since no standard DEVS metamodel is currently adopted, every group of researchers developed their own DEVS metamodel [3] [7] [1]. Authors in [3] introduced the first mapping concepts which were then extended covering additional areas which includes additional types of BPMN tasks [1] and the notion of resource allocation and failure [4]. Nevertheless, only a few BPMN concepts are integrated into these works. They still miss some essential features such as intermediate events, interrupting events, message flows, etc. In addition to the transformation of BPMN to DEVS, many researchers analyzed the transformation to other discrete event simulation models such as Petri nets [11]. However, it is more convenient to simulate models using DEVS rather than Petri

nets as the notion of time is not natively defined in Petri nets [21]. Moreover, DEVS provides a generalized framework of the modeling and simulation systems and offers a formal definition of the simulator [20].

5 SIMULATION APPLICATIONS

To have simulation results as realistic as possible, it is necessary to add simulation parameters that best describe the real world. The BP simulation tools currently available in the market differ in terms of simulation capabilities which affects the accuracy of the results. Simulation tools may be segmented into three categories [15] :

- Business process modeling or management tools with simulation support (e.g., ADONIS, ARIS Toolset, Bizagi Modeler, L-SIM, Simul8, PragmaDEV)
- General-purpose simulation tools (e.g., Arena, AnyLogic)
- Stand-alone business process simulators (e.g., Bimp)

Bizagi, L-SIM, and Simul8 use the BPSIM standard. The simulation properties of several BP simulation tools were evaluated in terms of the following criteria : Context Definition, Time Consumption, Control, Resources, Costs, and Priorities. Most business process simulation tools are commercial or not fully open source, requiring a proprietary license to simulate BPMN. Therefore, it is still difficult to verify and validate simulation results since the simulation semantics are not explicit, which makes reproduction of the experience challenging to control and hence the need for open-source, reusable, and flexible simulators. Academia and the industry developed several DEVS tools. These tools differ by design goals and specific programming language implementations. An evaluation of available DEVS simulators was performed comparing them in terms of formalism, compliance, features, and performance [19].

6 METHODOLOGY

BPMN is designed to represent business processes without any concerns for simulation. Our goal is to be able to simulate BPMN models by adding the necessary simulation parameters. BPSIM is a specification by the Workflow Management Coalition (WPMC) that defines the parameterization of business process models from different perspectives allowing process analysis, simulation, and optimization [17]. We have then chosen to extend BPMN2.0 standard with BPSIM2.0 standard for the specification level. The extended BPMN (BPMN+BPSIM) model may then be simulated with several existing BPSIM-able Simulation engines, which understands and process the semantics existing in the extended model. At the operational level, we have chosen the transformation into the DEVS model as it already considers the temporal dimension [21] and because a lot of work has already been conducted in this area. Moreover, the existing BPSIM simulators are proprietary and thus difficult to adapt to specific contexts. In this context, we aim to transform BPMN models extended with BPSIM into DEVS models that can be simulated/operated to detect errors and improve the business process as described in Figure 1. The extended BPMN model (BPMN+BPSIM) is transformed to its respective DEVS model based on a defined set of mapping and transformation rules. The final goal is to obtain a simulation tool that is open, extensible, and based on standards.

6.1 Extension with BPSIM

BPSIM 2.0 open-source specification document offers a straightforward method to incorporate BPSIM attributes and semantics onto BPMN. The purpose of this work is to enrich the conceptual model by extending selected BPMN elements with information on related parameters and logic that are significant for the simulation model issued from BPSIM. The BPSIM perspective consists of five parameters described in the BPSIM specification [17] (time,

control, cost, property and priority).

Every parameter of this perspective is a class group containing sub-elements defined based on their role in the simulation. BPSIM standard checks the validity of assigning the parameter to a specific BPMN element using a set of rules listed in the BPSIM specification document. Not all parameters are valid to be assigned to different BPMN elements. For instance, time parameters may be assigned to BPMN tasks and activities which have their details defined, unlike subprocesses. Control Parameters may not be assigned to connecting objects, swim lanes, artifacts, and attributes. Functionality is also represented at the level of the BPMN element type, such that within property parameters, message flows may be assigned property but not queue length. BPSIM provides several additional features to BPMN, such as : probabilistic distribution, assigning resources to activities, probabilistic duration, probability of Branch selection, duration parameter, priority of resources, etc.

6.2 Transformation from (BPMN + BPSIM) to DEVS

As our goal is to transform BPMN+BPSIM models into DEVS models, we need a metamodel for both source and target and a language to express rules of transformation. The BPMN metamodel is defined clearly as UML in the BPMN 2.0 OMG specification [12], while BPSIM elements are also described in the BPSIM specifications [17]. Nevertheless, we still need to acquire a unique BPMN+BPSIM metamodel that we intend to build from existing BPMN and BPSIM ones. For the target model, currently, there is no unique metamodel for DEVS. The existing DEVS metamodels are dependent on the environment where the model is being simulated. The need for a universal metamodel for DEVS has been addressed in the research community who proposed partial metamodels of DEVS. Although these propositions have been used in conceptual and technical works,

no consensus and standardization were reached. In the most recent work, a conceptualization of DEVS formalism using a universal representation of DEVS metamodel was suggested to combine both theory and practice points of view. It incorporates all DEVS views (abstraction, formalization, and implementation) into a traceable network of metamodels to be used in a compliant fashion [2]. To set rules for the transformation, we need a specialized language : several ones have been proposed to achieve model transformations, out of which are the extensible stylesheet language transformation (XSLT) and Atlas Transformation Language (ATL). XSLT is a standard used to process XML documents by transforming the XML to another schema or format after identifying mapping patterns while ATL is a model transformation language and toolkit developed on top of Eclipse. ATL provides ways to produce target models from a set of source models. ATL tools support the major tasks involved in using a language : editing, compiling, executing, and debugging [6]. ATL method was chosen to transform BPMN to DEVS in [1].

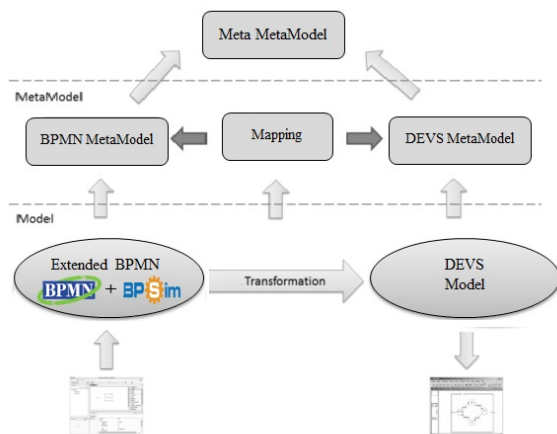


FIGURE 1 – Extension and Transformation architecture

7 CONCLUSION

This paper reviewed works concerning BPMN and simulation of business models. It shows that simulation tools already exist, but most Business Processes simulation applications are proprietary when it comes to BPMN. Our purpose is to offer an open-source web platform for the modeling and simulation of business processes based on universal standards : BPMN for the modeling and DEVS for the simulation by extending BPMN with BPSIM specification and using DEVS for operational simulation. Our work will focus on the three following points : defining a BPMN + BPSIM metamodel, defining a universal DEVS metamodel, and expressing transformation rules from (BPMN+BPSIM) to DEVS. The resulting tool is destined to any user (experts and non-experts in simulation) and is intended to be open source, allowing society to contribute to future enhancements.

References

- [1] Hassan Bazoun and al. Business Process Simulation : Transformation of BPMN 2.0 to DEVS Models. In *SCS/ACM/IEEE Symposium on Theory of Modeling and Simulation part of SpringSim 2014*, Tampa, United States, April 2014.
- [2] Maria Julia Blas, Silvio Gonnet, and Bernard P. Zeigler. Towards a Universal Representation of DEVS : A Metamodel-Based Definition of DEVS Formal Specification. In *Proceedings of the 2021 Annual Modeling and Simulation Conference, ANNSIM 2021*. Institute of Electrical and Electronics Engineers Inc., July 2021.
- [3] Deniz Cetinkaya, Alexander Verbraeck, and Mamadou Seck. MDD4MS : A model driven development framework for modeling and simulation. In *Proceedings of the 2011 Summer Computer Simulation Conference*, pages 113–121, June 2011.

- [4] Andrea D'Ambrogio and Grégory Zacharewicz. Resource-based modeling and simulation of business processes. In *SCSC '16. Summer Computer Simulation Conference*, Montreal, Canada, July 2016.
- [5] Tábara Fernandes Pereira and al. Methodology for the management of discrete event simulation projects based on pm-bok® : action research in a high-tech company. In *2018 Winter Simulation Conference (WSC)*, pages 4002–4013. IEEE, 12 2018.
- [6] The Eclipse Foundation. ATL, 2021.
- [7] Stéphane Garredu, Evelyne Vittori, Jean François Santucci, and Paul Antoine Bisgambiglia. A meta-model for DEVS : Designed following Model Driven Engineering specifications. In *SIMULTECH 2012 - Proceedings of the 2nd International Conference on Simulation and Modeling Methodologies, Technologies and Applications*, pages 152–157, 2012.
- [8] Sihem Mallek, Nicolas Daclin, and Vincent Chapurlat. The application of interoperability requirement specification and verification to collaborative processes in industry. *Computers in Industry*, page to be appear, May 2012.
- [9] Tom Mens and Pieter Van Gorp. A Taxonomy of Model Transformation. *Electronic Notes in Theoretical Computer Science*, 152 :125–142, 2006.
- [10] Dimitris Mourtzis. Simulation in the design and operation of manufacturing systems : state of the art and new trends. *International Journal of Production Research*, 58(7) :1927–1949, 2020.
- [11] Umair Mutarraf and al. Transformation of Business Process Model and Notation models onto Petri nets and their analysis. *Advances in Mechanical Engineering*, 10(12), December 2018. Publisher : Sage Journals.
- [12] OMG. *Business Process Model and Notation (BPMN) 2.0.2*, 2013.
- [13] B. S. S. Onggo and al. A BPMN extension to support discrete-event simulation for healthcare applications : an explicit representation of queues, attributes and data-driven decision points. *Journal of the Operational Research Society*, July 2017.
- [14] Muhammad Anwar-ur-rehman Pasha and Shaheen Pasha. bloom's taxonomy for standardizing bpm education of it undergraduates students. *Journal of Computer Applications*, pages 6–13, 09 2013.
- [15] Luise Pufahl, Tsun Yin Wong, and Matthias Weske. Design of an Extensible BPMN Process Simulator. In Ernest Teniente and Matthias Weidlich, editors, *Business Process Management Workshops*, pages 782–795. Springer International Publishing, 2018.
- [16] Luis Jesús Ramón Stroppi, Omar Chiotti, and Pablo David Villarreal. Extending BPMN 2.0 : Method and tool support. In *Lecture Notes in Business Information Processing*, volume 95 LNBIP, 2011.
- [17] Wfmc. *Business Process Simulation Specification (BPSIM)*, 2016.
- [18] Jon Whittle, John Hutchinson, and Mark Rouncefield. The State of Practice in Model-Driven Engineering. *IEEE Software*, 31(3) :79–85, May 2014. Conference Name : IEEE Software.
- [19] Van Tendeloo Yentl and Vangheluwe Hans. An evaluation of DEVS simulation tools, 2017.
- [20] Grégory Zacharewicz and Maâmar El-Amine Hamri. Flattening G-DEVS / HLA structure for Distributed Simulation of Workflows. In *AIS-CMS International modeling and simulation multiconference*, pages 11–16, Buenos Aires, Argentina, February 2007.
- [21] Bernard P. Zeigler, Herbet Praehofer, and Tao Gon Kim. *Theory of Modeling and Simulation*. Elsevier, Academic Press, second edition edition, 2011.