

Waiting for the Miracle

Comparative Analysis of Twelve Business Process Management Systems Regarding
the Support of BPMN 2.0 Palette and Export

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Abstract

The Business Process Model and Notation 2.0 (BPMN 2.0) is a specification issued by the Object Management Group (OMG) widely used in Business Process Management Systems (BPMS). It defines a graphical language for modelling business processes as well as an XML serialization of it that should enable model interchange between different modelling tools. This work evaluates 12 BPMS, regarding the support of the BPMN 2.0 graphical palette and the conformance of the diagrams exported with the tools to the normative XML Schemas defined by the specification. Four reference business processes of increasing complexity, designed according to an already existing taxonomy of processes from the literature, are used as benchmarks. The results of the study show that most tools offer only a partial support of the BPMN 2.0 palette. Only one tool allows the modelling of all reference processes with minor limitations. Moreover, most exported files contained errors with respect to the XML Schemas from the OMG. All in all, the capabilities of most evaluated tools are clearly not sufficient to practically enable a robust interchange of models between tools. The report ends by highlighting the limitations of this study and by providing recommendations for future evaluations of BPMN 2.0 conformance in tools. This document is a comprehensive summary of the work presented in [11].

Keywords: Business Process Management Systems, BPMN 2.0, Diagram Interchange, Comparison, XML Schema, Compliance

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1 Introduction

The Business Process Model and Notation (BPMN) has become a standard for modelling business processes. The first version of the specification was published in 2004 by the Business Process Management Initiative. Their goal was to deliver a standardised graphical process notation that can be understood by business people and IT alike, and which can also be used as a basis towards the automation of processes. The Object Management Group (OMG) took over the Business Process Management Initiative in 2005 and continued developing the notation. In 2009, BPMN 1.2 was released. While providing a number of improvements, it was still focused on the graphical representation of processes. In January 2011, the OMG released the specification of BPMN 2.0. The main novelty of BPMN 2.0 is that it specifies an XML format for storing BPMN models, and not only the graphical language that must be used. Furthermore, BPMN 2.0 includes execution-related metadata that allows workflow engines to execute the BPMN models directly without having to convert them into another language (e.g. BPEL) for this purpose. In addition, BPMN 2.0 also provides an extended graphical palette (new symbols, new diagram types).

As BPMN has become widespread, there are a number of software tools that support it. Before BPMN 2.0 however, it was difficult (not to say hardly possible) to interchange BPMN diagrams between tools. However, an explicit objective of BPMN 2.0 was to allow such diagram interchange, as stated explicitly in the specification:

One of the main goals of this specification is to provide an interchange format that can be used to exchange BPMN definitions (both domain model and diagram layout) between different tools [5, p.9].

The goal of the research presented in this report is to evaluate the interchange capabilities of available Business Process Management Systems (BPMS). More specifically, we will analyse the support of the BPMN 2.0 palette (graphical symbols) and the conformance of BPMN 2.0 files produced by the tools to the normative XML Schemas provided by the OMG as part of the BPMN 2.0 specification.

This document is structured as follows. In Section 2, we briefly present the BPMN 2.0 palette and export format. Then we introduce our evaluation methodology in Section 3. Then, Section 4 summarizes the results of the comparative analysis and Section 5 presents the related work. We discuss the limitations of our study in Section 6

2 BPMN 2.0 Palette and Export Format

On the one hand, BPMN 2.0 is a graphical notation for representing business processes. Therefore it provides a predefined and extensible set of shapes, and defines the rules for combining them. In this report, we call "BPMN 2.0 palette" the set of graphical symbols used for modelling BPMN 2.0 diagrams. The predefined symbols are depicted in section 7.2 of the BPMN 2.0 specification [5].

On the other hand, BPMN 2.0 also specifies a file format for diagram interchange between modelling tools. To this end, an XML Schema (XSD) file is associated with the BPMN 2.0 specification. It gives a formal representation of the BPMN 2.0 metamodel. In other words, it describes the schema that serialized BPMN 2.0 diagrams must conform to in order to allow diagram interchange. This schema is BPMN20.xsd, which imports and includes several other schemas. We briefly present them hereafter.

DC.xsd (Diagram Commons) defines the common graphical elements found in diagrams. It defines the following elements: Font, Point, Bounds.

DI.xsd (Diagram Interchange) imports DC.xsd and defines the classes of other graphical elements, namely: DiagramElement, Diagram, Style, Node, Edge, Shape, Plane, LabeledEdge, Label,

LabeledShape. DC.xsd and DI.xsd are an attempt to specify the elements of a generalized (i.e. not only BPMN) diagram representation.

BPMNDI.xsd (BPMN Diagram Interchange) extends the elements from DC.xsd and DI.xsd to define their actual BPMN equivalents. It does so in particular by providing the link between the visual depiction of the shape (from BPMNDI.xsd) and the actual BPMN element (from Semantic.xsd). The following elements are defined in this file: BPMNDiagram, BPMNPlane, BPMNLabelStyle, BPMNShape, BPMNLabel, BPMNEdge.

Semantic.xsd (Semantic) defines the classes of all the remaining elements of the BPMN 2.0 meta-model. A total of 131 elements are defined in this schema. This includes, for example: activity, artifact, choreography, collaboration, dataAssociation, endEvent, lane, parallelGateway, scriptTask, ...

BPMN20.xsd (BPMN 2.0) specifies the top-level architecture of a BPMN 2.0 file. It defines two classes: definitions and import. This schema includes Semantic.xsd (i.e. using the same target namespace) and imports BPMNDI.xsd (i.e. using a different target namespace).

As this work only deals with the export of diagrams and not their import, we refer to the interchange format as the "export format" in the remainder of this report.

3 Methodology

Our evaluation methodology was the following:

1. Select a dozen relevant BPMS that claim to support BPMN 2.0.
2. Define levels of BPMN 2.0 support and a reference process at each level.
3. Model the reference processes in each BPMS and evaluate the support of the BPMN 2.0 palette at each level.
4. Export the process models to BPMN 2.0 and evaluate the support of the BPMN 2.0 export at each level.

In this section, we detail how the BPMS were chosen. We also explain how the BPMN 2.0 support levels and corresponding reference processes were defined. Finally, we describe the evaluation protocol and our criteria of BPMN 2.0 support.

3.1 Selection of BPMS

As of November 2011, there were 73 tools listed in the non-exhaustive list of BPMN implementors on the OMG website¹. Obviously we could not afford to evaluate all of them, but only about a dozen. Starting from the OMG list, we reduced it by picking only the tools that appeared in Gartner and Forrester research papers [7, 10]. We also included additional open source products. The new list contained a total of 41 products. To reduce it even further, we examined the claims to support BPMN 2.0. We browsed vendors' websites and, when necessary, contacted them directly to ask whether their tool supports BPMN 2.0 (palette and export) and, if yes, if we could obtain an evaluation license for the sake of this work. Twelve tools remained in our final list. They are, by alphabetical order:

- Activiti BPM Platform 5.7
- Bonita Open Solution 5.5.2

¹http://www.omg.org/bpmn/BPMN_Supporters.htm

- IBM Blueworks Live
- imeikas BPMN2 Visual Editor for Eclipse
- Intalio BPMS Designer 6.0.3 Community Edition
- ITP-Commerce Process Modeler 5 SR6 (Professional)
- JBoss jBPM5 5.1
- Joinwork Process Studio 3.1
- MID Innovator for Business Analysts - Enterprise Edition 11 R4
- Oracle BPM Suite 11gR1
- Signavio Oryx BPM Academic Initiative
- Visual Paradigm Business Process Visual ARCHITECT 4.2 SP2

3.2 Reference Processes

Some classification schemes of BPMN process models were already proposed in the literature. Bruce Silver [9, pp. 6–8;189–190] proposes three levels of modeling: descriptive, analytical and executable. Each level is an extension of the prior and the executable level adds execution properties for each element in the model. As our work is not concerned with execution, this structure does not seem ideal. Jakob Freund and Bernd Rucker [3, pp. 184–186] propose a classification of BPMN symbols based on their frequency of use, supported by empirical evidence (questionnaires). Symbols may be used "always", "frequently", "every now and again", "rarely" and "hardly ever". As it is based on the empirical usage of symbols, this classification completely ignores the semantics of BPMN. For example, by employing only "always used" symbols, it is not possible to model a semantically correct BPMN diagram. Consequently, we cannot use this classification for our purposes. In the BPMN 2.0 spec, OMG defines three conformance classes [5, pp. 32-37;509]: descriptive, analytic and common executable. The problem with these conformance classes is that even the lowest level (descriptive) contains elements and attributes used in high-level modelling environments. As the focus of this work is put on the palette and export, these classes are not well suited.

Finally, Bruce Silver and Robert Shapiro [8, pp. 226–231] propose a four-classes taxonomy of processes inspired by the condition of modelling. The simplest level is meant to be used to model a process on a whiteboard with process owners, thus providing a basic palette. The second level improves on the previous one by adding data flows, more complex routing logic, resources and so on. The third level even enriches the previous one by providing, for example, intermediate events. Finally, the last level provides the full BPMN 2.0 palette. Furthermore, Silver and Shapiro provide an example process for the "simple" and "descriptive" levels. We decided to leverage Silver and Shapiro's taxonomy of processes and take their examples as reference processes in our evaluation. Thus the four levels of BPMN 2.0 support we used are:

- Simple (see reference process on Figure 1)
- Descriptive (see reference process on Figure 2)
- Analytic (see reference process on Figure 3)
- Complete (see reference process on Figure 4)

The two first reference processes were taken and adapted from [8]. The two others were designed by us on the basis of Silver and Shapiro's taxonomy. The reference processes depicted in the figures were drawn using Microsoft Visio and the plugin from BPM-Guide.de²

²http://www.bpm-guide.de/wp-content/uploads/2008/10/BPMN_2.0.vss

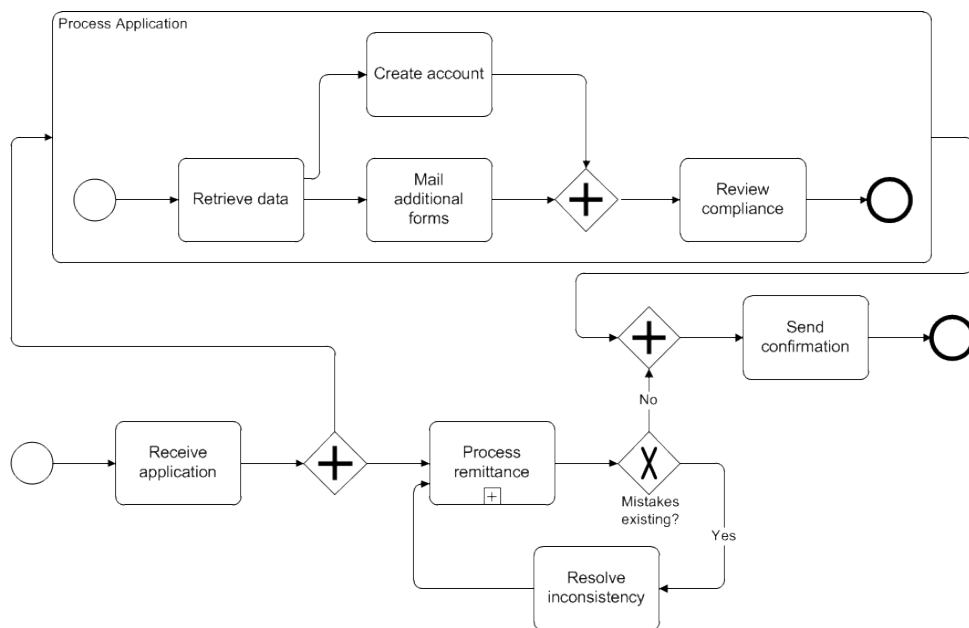


Figure 1: Reference process "simple", modified from [8].

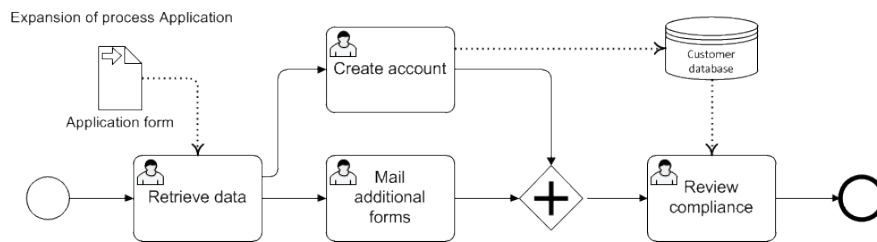
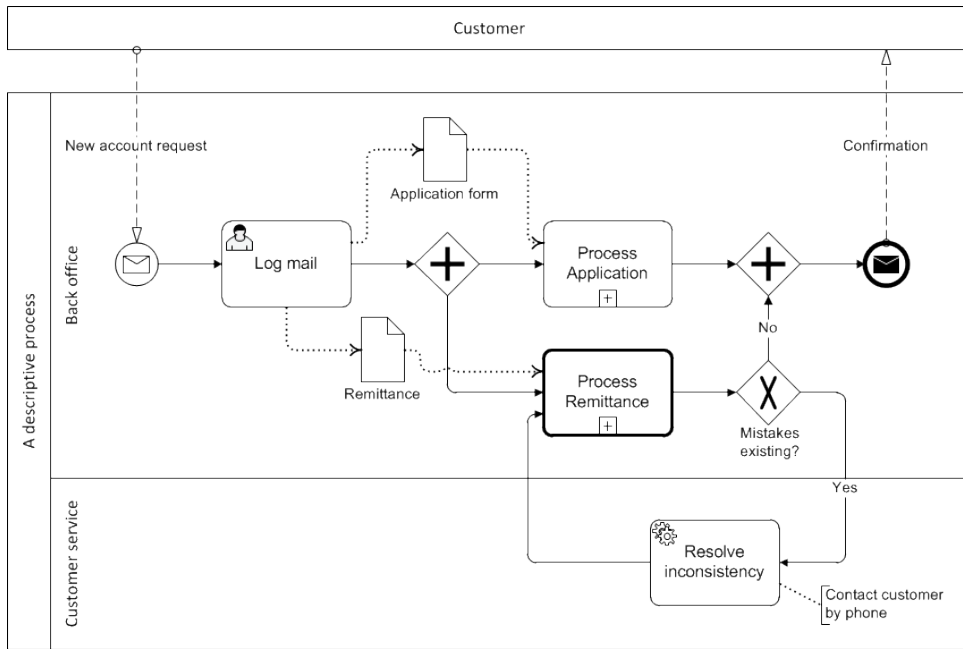


Figure 2: Reference process "descriptive", modified from [8].

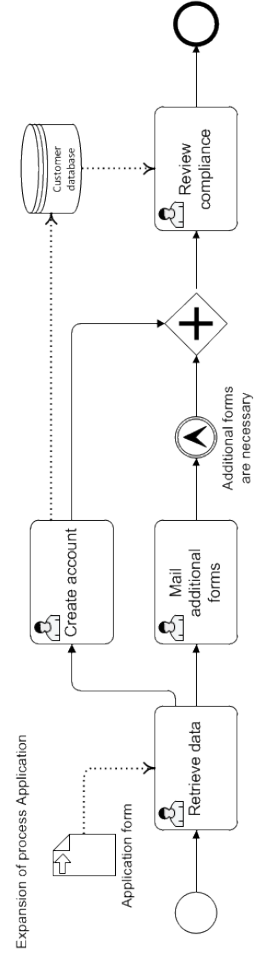
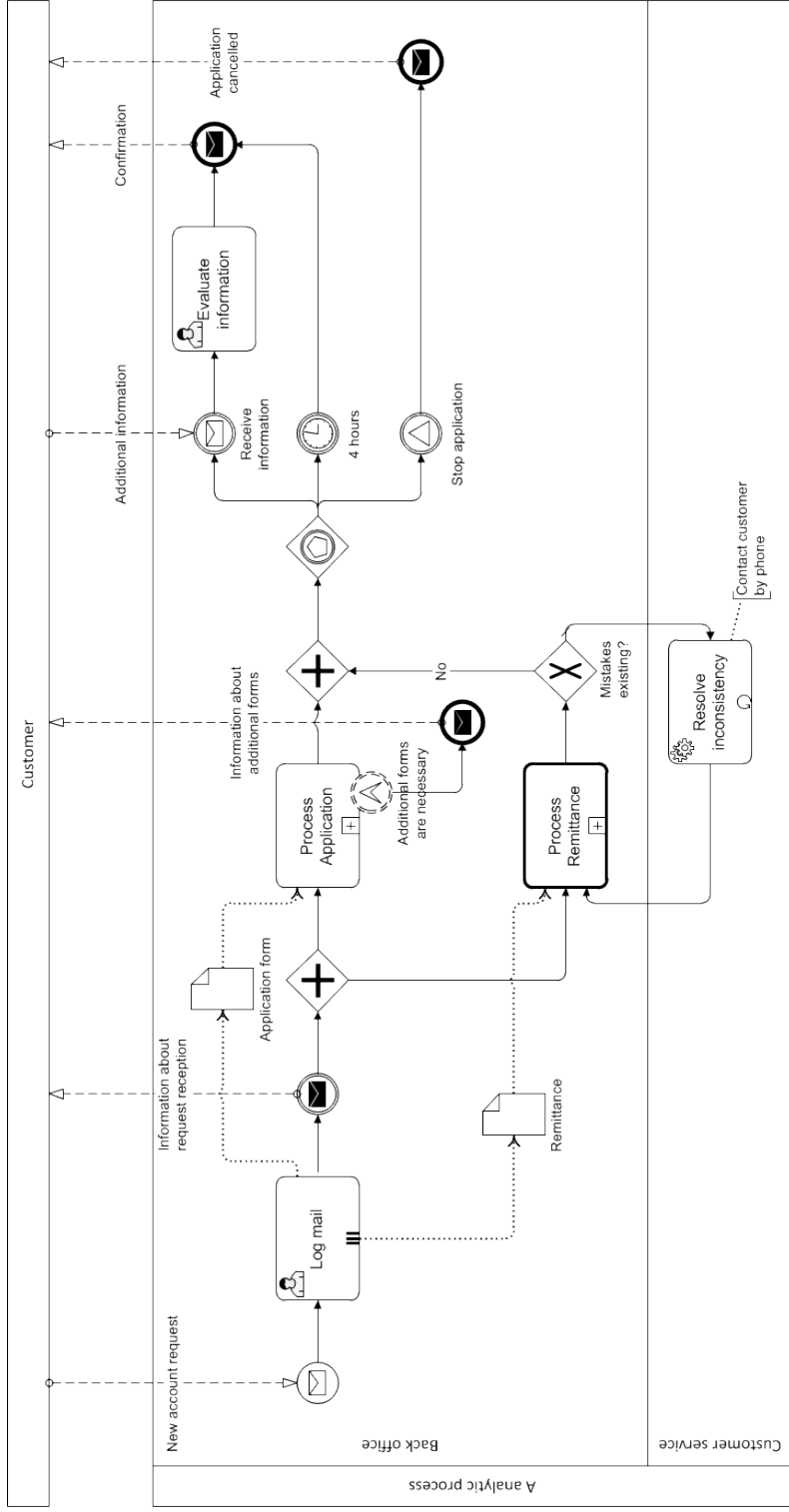


Figure 3: Reference process "analytic", inspired by [8].

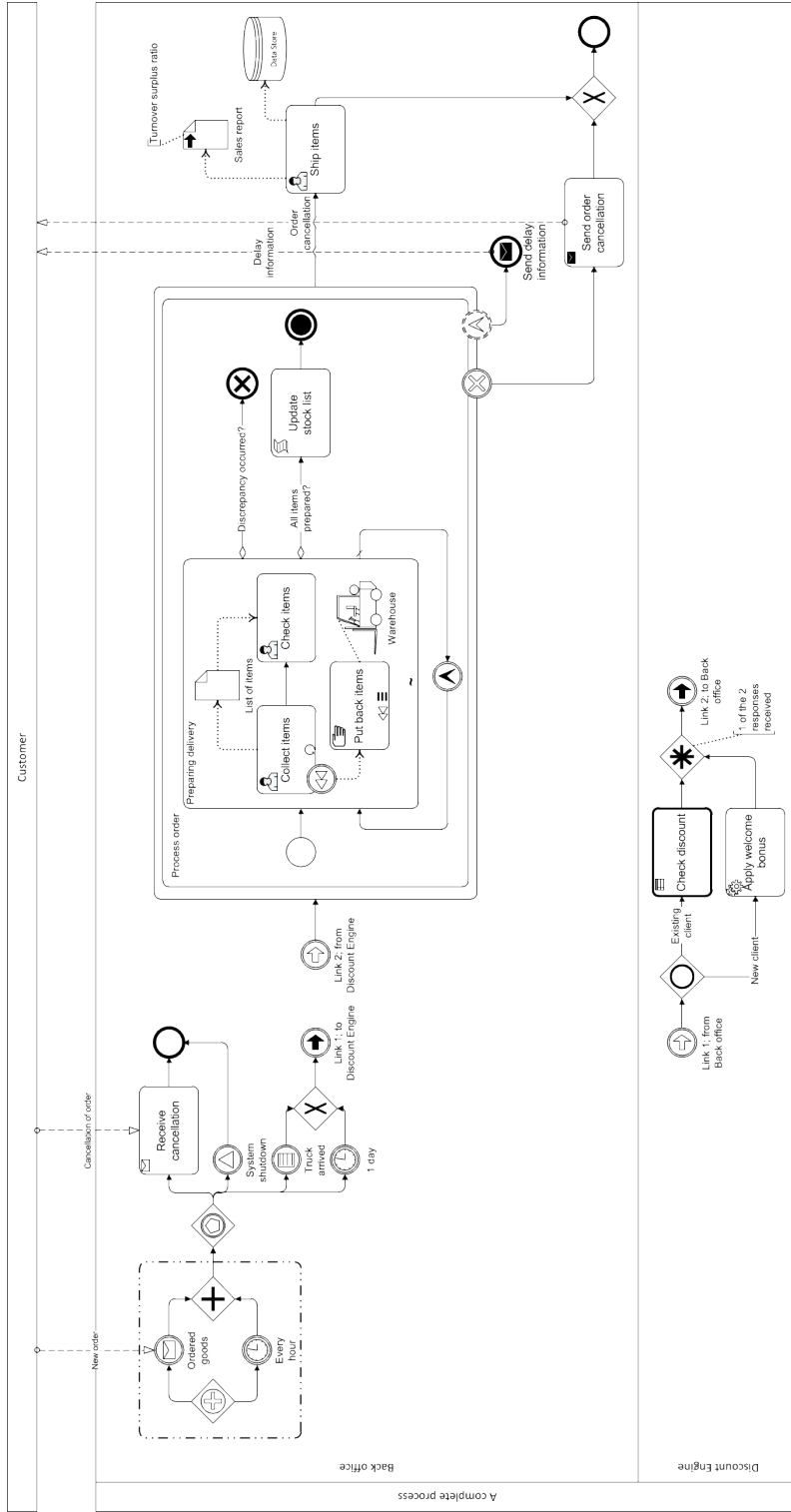


Figure 4: Reference process "complete", inspired by [8].

3.3 Evaluation Protocol and Criteria

3.3.1 BPMN 2.0 Palette

With each modelling tool, we model the four reference processes by increasing order of complexity. If the palette of the considered tool is not sufficient, we try to find a workaround that preserves the semantics of the reference process. If this is impossible, the modelling is abandoned altogether at this point and we do not attempt to model more complex processes using this BPMS. Thus, our criteria for the support of the BPMN 2.0 palette are, for each reference process:

- Are all the shapes available?
- Is it possible to reproduce the reference process graphically?
- If one of the above is not met, is there a workaround preserving the semantics of the reference process?

Consequently, for each reference process, a given BPMS may provide:

Full support if it is possible to produce a model graphically identical to the reference process.

Partial support if a workaround preserving the semantics is possible.

Insufficient support otherwise.

3.3.2 BPMN 2.0 Export

After each reference process is modelled in a satisfying manner, we export the resulting model. Then we open it using an XML editor (Microsoft XML Notepad 2007³) and validate it against the XML schemas defined by the OMG and presented in section 2. Thus, our criteria for the support of the BPMN 2.0 export are, for each reference process:

- Does the file contain the correct schemas and namespaces declarations?
- Is the file valid with respect to the schemas?

Thus, for each reference process, a given BPMS may provide:

Full support if the exported BPMN 2.0 file is valid.

Insufficient support if there are validation errors.

4 Results

We present in this section a brief summary of the results. A detailed report is available in [11].

4.1 Support of BPMN 2.0 Palette

We modelled the reference processes in the tools according to the methodology described above. Modelling 4 reference processes in every 12 tools should have produced 48 models. However, 9 diagrams (8 "complete", 1 "analytic") could not be modelled at all due to insufficient palette support in the tools. Thus, 39 processes were modelled in the end. Of those 39 processes, only 7 were found to benefit from a full support of the tools, whereas for the other 32, workarounds had to be found. Moreover, Signavio Oryx is the only tool that offers a full support of the BPMN 2.0 palette required to model all 4 reference processes. There were only two limitations appearing with this tool for the

³<http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=7973>

Evaluated BPM System	Reference Process			
	Simple	Descriptive	Analytic	Complete
Activiti BPM Platform	●	●	●	○
Bonita Open Solution	●	●	●	○
IBM Blueworks Live	●	●	●	○
imeikas BPMN2 Visual Editor	●	●	●	●
Intalio BPMS Designer CE	●	●	●	○
ITP-Commerce Process Modeler	●	●	●	●
JBoss jBPM5	●	●	○	○
Joinwork Process Studio	●	●	●	○
MID Innovator	●	●	●	○
Oracle BPM Suite	●	●	●	○
Signavio Oryx	●	●	●	●
Visual Paradigm Visual Architect	●	●	●	●

Table 1: Support of BPMN 2.0 graphical palette for reference processes at the levels proposed by [8]. Legend: ● means full support, ● means partial support and ○ means insufficient support.

“complete” reference process: (1) one cannot use custom artefacts and (2) link intermediate events are considered off-page connectors and cannot be used within a single diagram. These limitations are minor compared to the ones found in other tools. With respect to that, Signavio Oryx may still be considered to offer “full support” of the palette required for the “complete” reference process.

The problems that appeared the most often were related to:

- Events (unavailable events) – 16 occurrences
- Annotations (unavailable shapes, no directional annotation flows) – 14
- Subprocesses (unavailable subprocess types, wrong depiction) – 10
- Pools (no pools, no black-box pools, only one pool) – 9
- Activities (some activity types not available) – 7

Table 1 summarizes the support of the BPMN 2.0 palette in the different tools.

4.2 Support of BPMN 2.0 Export

To evaluate how the selected BPMS support BPMN 2.0 export, we exported the 39 processes successfully modelled in the previous phase, including the models containing workarounds in case the BPMN 2.0 palette was only partially supported. First, it appeared that most tools did not include the schemas declaration in the preamble of the exported files, nor specified the namespace of the schema files. In order to validate those files, we had to link the XML Schemas and namespaces manually. As 9 tools out of 12 did not include the schemas declaration, we did not consider it a qualifying criterion. However, even with this constraint relaxed, many files were still not valid with respect to the schemas. Of the 39 processes exported indeed, 8 processes, produced by only three tools, were found fully valid (i.e. including proper schemas declaration). Without taking into account the missing XML schemas declaration, 21 processes were valid. In the remaining, 17 processes contained validation errors and 1 could not be exported, causing the application to crash.

Evaluated BPM System	Reference Process			
	Simple	Descriptive	Analytic	Complete
Activiti BPM Platform*	○	●	●	–
Bonita Open Solution*	○	○	○	–
IBM Blueworks Live*	●	●	●	–
imeikas BPMN2 Visual Editor*	○	○	○	○
Intalio BPMS Designer CE*	●	●	●	–
ITP-Commerce Process Modeler	●	●	○	○
JBoss jBPM5*	●	○	–	–
Joinwork Process Studio*	●	○	○	–
MID Innovator*	○	○	○	–
Oracle BPM Suite*	●	●	●	–
Signavio Oryx	●	●	●	?
Visual Paradigm Visual Architect	●	●	●	○

Table 2: Support of BPMN 2.0 export for reference processes at the levels proposed by [8]. Legend: ● means full support, ○ means insufficient support, – means not tested, and ? means the application crashed during export. The * marks tools that do not declare the XML schemas in the exported file.

Besides the lack of XML schemas declarations, the validation errors encountered the most often were the following:

- Missing required attribute – 10 occurrences
- Incomplete element content – 10
- Invalid child element – 10
- Invalid attribute or element – 9
- Duplicate identifier – 8
- Reference to undeclared identifier – 5
- Invalid data type – 4

Table 2 summarizes the support of the BPMN 2.0 export in the different tools.

5 Related work

There exists a number of studies and comparisons of Business Process Management Systems. Some of the most famous ones are done by Gartner [2, 10], Forrester [7], the Fraunhofer-Institut [4] or the Business Application Research Center [1]. The results presented in those studies generally consist of high-level indicators, where market presence and vendor strategy play a key role, whilst a criteria like normative BPMN support is clearly secondary. A study most similar to ours was done by [6]. Its author evaluates the interoperability of three BPMN tools by modelling three different processes in each tool, exporting the process models and importing them in the other tools. The author then evaluates the quality of interoperability by examining how each BPMN element can be exported and imported in all scenarios. Our research differs from that one in different aspects. First, the reference

processes are not the same. [6] have three reference processes that were initially in BPMN 1.2 and were adapted to BPMN 2.0. We have four reference processes, that were explicitly based on BPMN 2.0 from the start. Second, their study covers the whole interchange process (including import) and is more fine-grained, evaluating the support of tools for the interchange of all specific BPMN elements. Our study focuses on the palette and on the quality of export at a coarser-grained level, without evaluating each element in isolation. This allows us to compare 12 different tools including commercial ones, while [6] analyses only 3 open-source tools. Therefore our work can be seen as complementary to that research.

6 Limitations and Perspectives for Future Comparative Analyses

We examine in this section the limitations of our study and propose some guidelines for future comparative analyses of BPMN 2.0 support in tools.

6.1 Conformance Classes

After an informal review of this report, Bruce Silver kindly provided us with an historical background of the conformance classes presented in Section 3. Actually, the alternative taxonomies presented there were not devised in isolation from one another, but rather they occurred sequentially. Bruce Silver's classes (simple, descriptive, executable) were introduced in [9] with a pedagogical goal in mind. The four classes taxonomy, presented in [8] and used in our study, was developed by Silver and Shapiro. Moreover, both Silver and Shapiro belonged to the OMG BPMN 2.0 committee and pushed for those conformance classes to be included in the specification. In the end, the OMG included the 3 classes "descriptive", "analytic" and "common executable" as a compromise between Silver and Shapiro's classes and propositions of other members of the OMG committee. Knowing this, we go along with Bruce Silver's suggestion to *use the OMG classes for conformance testing* in future comparative analyses of BPMN 2.0 support in tools. The BPMN 2.0 specification should be the authority for conformance testing.

6.2 Lack of Support versus Implementation Bugs

Our study does not distinguish between a complete lack of support for certain features in tools and implementation bugs in features that the tools claim to support. This difference should be taken into account in future studies, as implementation bugs are generally quickly fixed in future releases of the tools. To the contrary, unsupported features require a lot more effort to make them available in tools. Indeed, at the time of writing, new releases of some tools (e.g. ITP Commerce) have already fixed the implementation bugs highlighted in our study. *Future comparative analyses should clearly distinguish between unsupported features and implementations bugs in tools.*

7 Conclusion

This report has presented a comparative analysis of twelve Business Process Management Systems regarding their support of the BPMN 2.0 palette and export capability. The evaluation methodology consisted in using the tools to model and export four reference processes based on a taxonomy found in the literature, which represent four different levels of usage of the BPMN 2.0 specification. The results show that there is still much work to do on the part of BPMN implementors to ensure a proper conformance to the specification. Only one tool allowed the modelling of all reference processes with minor limitations. Regarding export, five tools performed reasonably well with the process that they could model. However, most exported files lack proper XML schemas and namespaces declaration in their preamble. The study presented here also has some limitations, that future similar

evaluations should try to avoid. In particular, future studies should be based on the conformance classes defined in the specification, which are authoritative. Furthermore, they should distinguish clearly between a complete lack of support for certain features in tools and implementation bugs that plague the support of certain other features.

The BPMN 2.0 specification is young. However, there is still a long way to go before BPMN diagram interchange is practically doable, even on the graphical level only. Future developments of business process management systems should address the issues mentioned in this report. Furthermore, as tools are continuously improved, researchers and practitioners alike are encouraged to conduct and publish comparative analyses that would complement the one presented here.

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