RESEARCH ARTICLE

Business Process Modeling Notation

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Abstract— Models as representations of real world entities may appear to the novice to be an unnecessary abstraction. Indeed, in small organizations where there are relatively few processes, there is little need to abstract activities. When it comes to large organizations, with hundreds or thousands of processes, the creation of models becomes an essential activity. Even if the process itself does not change in the form of new process re-engineering efforts or new applications, there are new employees and contractors who must learn how things work to become effective new members of the organization's human resource team. Without a roadmap that tells these new team members what goes on in their sections, and how their activity integrates into the overall activity of the organization, employees can develop a silo mentality that ignores the greater operation. This paper provides insight into how knowledge of business processes can be captured in a notation that standardizes the way we view activities within the organization. The process modeling notations of the Object Management Group (OMG) are the primary focus.

I. INTRODUCTION

This paper will describe the generic form of process analysis referred to as business process modeling. In the opening section, the general purpose of the process model will be explored. This will include the definition of a business process, how activity diagrams are used to model those processes, and where the **Business Process Modeling Notation** (BPMN) standard fits. The following sections will delineate how the standard works and its area of concern. BPMN is a relatively new standard as compared to the standards associated with other OMG subject matter areas such as UML. As a result, this paper will discuss when some elements from UML, such as the Activity Diagram, should be used, and when BPMN would be a better choice. The *BPMN Diagrams* section will illustrate an example of what a BPMN diagram looks like. That section will also provide an explanation of the contents of a typical BPMN model. The business benefits of the notation will be explored from the perspective of the business user. No notation is perfect, so one of the final sections before the *Conclusion* will outline how well the notation fares against a rigorous ontological standard.

There are a variety of opinions as to the precise definition of a business process. Siegel (2008) notes there are multiple definitions and that there is no absolute wrong or right. However, culling the definitions provided by authoritative sources cited by Siegel (2008) yields a workable definition for this paper. A business process is a network of coordinated coherent activities that interact to produce a business outcome (Siegel, 2008). Processes exist in and of themselves without the help of models. Human actors in the business environment can execute

current processes and define new processes without models. When those processes become complex however, modeling provides an invaluable aid because all actors can see their respective parts in the larger scheme and how they interact. Modeling therefore aids in better planning and coordination of change.

II. ACTIVITY DIAGRAMS

Activity diagrams offer a way to create a graphical illustration of a set of activities and the relationships between those activities (Dennis, Wixom, & Tegarden, 2012, p. 165). They are a part of the Unified Modeling Language (UML) as a method to document the way processes work from a requirements perspective (Dennis et al., 2012, p. 164). The elements of an activity diagram are the *branch* (a single incoming transition that leads to two mutually exclusive paths), the *merge* (multiple inputs that converge into a single output), and the *guard* (Boolean expressions that must evaluate to true for the transition to be followed) (Blaha & Rumbaugh, 2000, p. 95; Fowler & Scott, 2005, p. 131). One of the benefits of Activity Diagrams is that they are very good at depicting parallel activity.

Activity Diagrams differ in use and application from BPMN Models by virtue of their purpose. The purpose of Activity Diagrams is to elaborate business requirements by supplementing use cases and sequence diagrams (Blaha & Rumbaugh, 2005, p. 143). In fact, Blaha & Rumbaugh (2005) suggest that use of Activity Diagrams outside those contexts is tantamount to misuse and they further advise that Activity Diagrams "...should not be used as an excuse to develop software via flowcharts" (Blaha & Rumbaugh, 2005, p.143).

III. PURPOSE OF ACTIVITY DIAGRAMS

Given the aforementioned warnings regarding the misuse of Activity Diagrams, it should come as no surprise that the documentation of current state business processes is not part of the UML standard for Activity Diagrams. The documenting of the collaboration between business users, which may or may not involve information systems, is not an area where Activity Diagrams were meant to exist. Without a use case and its associated scenarios, the Activity Diagram would be the equivalent of a flow chart. This begs the question, "How do we obtain the benefit of the branches and swimlanes of Activity Diagrams to **support** the software development initiative, when some of the affiliated processes will not be targeted for update or change by the development effort?"

Situations where the business processes that support (but will not be supplanted by) the new system are a perfect place for BPMN. In this kind of situation, the background elements of the business process would serve as the foundation for the actors who interface with the system. An example would be a letter carrier who drops off the mail at a business location. An actor from the business takes the delivered mail, opens it, and finally scans it with the system that is the subject of the information system project. In this instance, the process the letter carrier uses feeds the actor who will interface with the new system. There is no intention of "automating" the U.S. Postal service as a part of the project under study. As such, the Activity Diagram would be a poor choice for modeling the letter carrying process.

IV. BPMN DIAGRAMS

BPMN is developed and standardized by the Object Management Group (OMG). It was first developed by a consortium of process modeling vendors in 2003 and work progressed for three years until in 2006, it was released as an OMG standard (Recker, 2010, p. 182). The charter for BPMN makes it clear that the purpose of BMPN is to help businesses understand their internal processes (OMG, 2012). It is essential that the business decision makers see their processes without regard to how a particular solution constrains the problem domain. In fact, as previously stated, there need not be a problem domain at all. This is the power of BPMN in the system development context. The capture of business process information can exist without an information system initiative, or it may support such an initiative by providing rich contextual information about the landscape that supports the information system.

V. DIAGRAM STRUCTURE

BMPM diagrams have four categories of graphical elements: flow objects, connection objects, swimlanes, and artifacts (White, n.d., pp. 2-6). The names for these objects are sometimes similar to designations used in an object oriented sense. Though not identical, there is meaningful overlap in the terms. When these term collisions occur, they will be noted in the text that follows.

The first collision occurs in the category of BPMN objects called *flow objects*. This category includes activities (an atomic unit of action in BMPN) and the gateway. The gateway has much in common with a *branch* in Activity Diagrams, in that it denotes a point where a decision is made. The elements within the flow object category are the most easily recognizable as they are very similar in appearance and use to traditional flow chart elements. This similarity is intentional and forms BPMN Level 1, or what is referred to as Descriptive BPMN (Centrum Systems, n.d.). In this basic level, the fundamental flow objects are used to help show how those involved in the process collaborate. Level 2 is called Analytical BPMN and its purpose is to provide a more precise description of how the process works. This higher level of expressiveness requires more symbols to support, and thus is less user-friendly for the novice (Centrum Systems, n.d.).

Level 3 BPMN is also called Executable BPMN, and its focus is on developers (Centrum Systems, n.d.). It is here that BPMN makes a move into the representation of programmatic elements as objects within the model. The intent of Level 3 is to integrate the Level 2 elements with the Extensible Markup Language (XML) to produce a process that can be made executable by a suitable interpreter or compiler (Centrum Systems, n.d.). This is the cutting edge for the BPMN standard. The goal of the BPMN creators was to bridge the gap between modeling languages and execution languages. This vision was similar to the current ability of database design software to take an Entity Relationship Diagram (ERD) and convert the standardized shapes and relationships it contains to create a set of Structured Query Language (SQL) commands. Those SQL commands can then be executed on any SQL-compliant platform to create new tables that have attributes and relationships, first outlined in the design diagram, without a Database Administrator (DBA) having to execute the commands. This functionality is now available in products such as ERwin (CA Technologies, 2013). Given this fact, the creators of BPMN envision similar functionality from a variety of BPMN-compliant products. These new products could even be deployed in web environments, which would expand the functions provided by the internal business to the outside world (Weerawarana, 2002).

The next group of elements are called *connection objects*, and they consist of the lines that connect elements of the diagram. Connection objects consist of sequence flows (connects elements within the same swimlane), message flows (connects elements from different pools), and associations (helps clarify inputs and outputs) (White, n.d., p. 3). The third group of elements is called *swimlanes*, and these components are used to segment the diagram into areas that contain a sequence of related activities connected by the sequence flows (White, n.d., p. 4). Swimlanes are a powerful communication symbol because they compartmentalize the diagram in such manner that it becomes apparent what entity is taking the action (activities and gateways that make up the operations and decisions) and how those actions relate to those of other elements.

The fourth and last group of objects in a BPMN diagram is called *artifacts*. Artifacts are elements that help group and annotate the model, so that the reader can better understand the context of the activities and actions that are depicted therein (White, n.d., p. 6). There are occasions when other important elements of a modern process flow take front stage in a process model. Databases, Data Warehouses, and Big Data are fast becoming the analytical tools used by data-driven organizations. To be comprehensive in its applicability to the modern business environment, BPMN needed to provide a symbol that could be used to model these data sources. The data object within the artifact object classification is the perfect element to depict the fact that data can be a critical part of the business process. In practice, data objects are included in the process flow with activities and gateways by connecting them with association flows. The association flow within BPMN is not the same as in UML. The association in BPMN is a dotted line that is used exclusively to connect data, text, and other elements from the artifact classification with elements of the flow object category.

The following is an example of a BPMN model. Within the model, there is quite a bit of activity. First there are the lanes which corral a class of activities into subordinate lanes. These lanes are often referred to as "swim lanes" due to their similarity to a swimming pool with well-defined boundaries between each lane of swimming competitors.
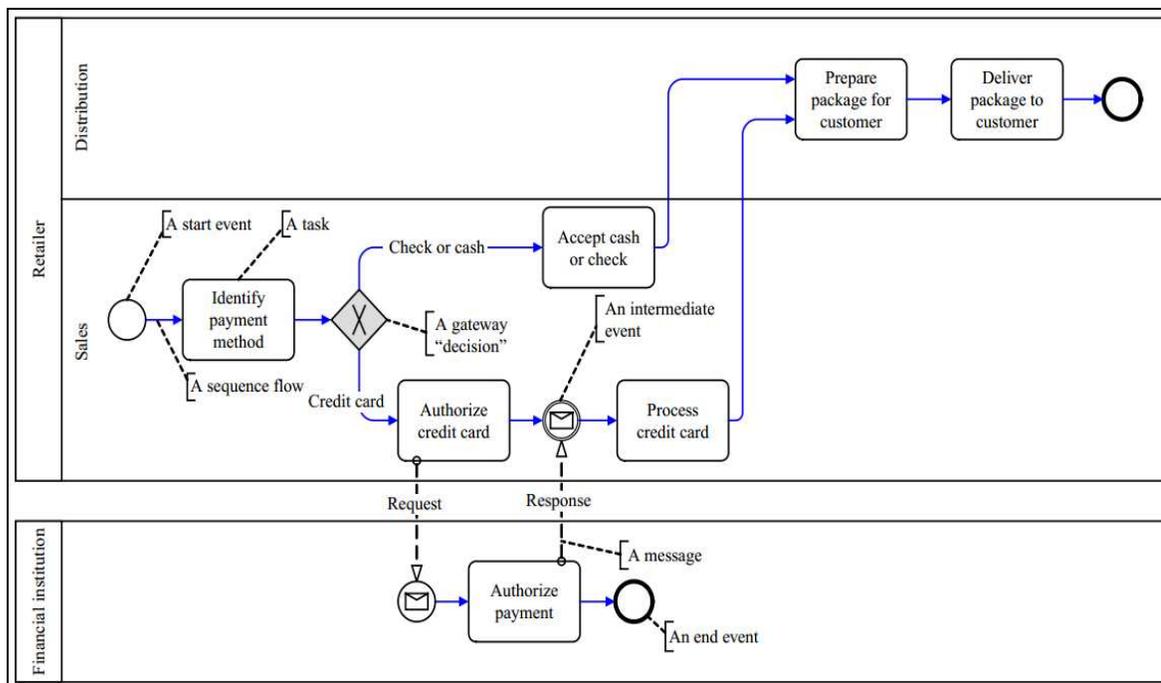
Figure 1: Example of a BPMN diagram (Recker, 2010, p. 184)

Some of the chief benefits of BPMN are standardization, interoperability, and ease of use. As of 2010, there were more than sixty vendors whose tools supported the standard (Recker et al., 2010, p. 502). This means the purchaser of a business process tool can do so with the confidence that they will not be locked into a proprietary standard. These first two benefits relate to the third in a strong way. Ease of use (of the notation standard, not the tools) comes from the fact that regardless of whether a diagram was produced using software or by hand, the resulting content can be easily understood by anyone familiar with the notation.

There is a benefit from the standard that is completely free to any organization that wishes to create BPMN-compliant documentation. It should be emphasized that an organization does not need to have BPMN software to create models that conform the BPMN standard. While it is true that a consortium of vendors helped make the standard happen, the standard does not require software from the vendors who participated in or were the catalyst for the standard. This speaks to the openness of BPMN. Microsoft Office Visio is an application that comes with a set of stencils to help the user create models that provide more insight into the collaborative and execution-based representations of the notation. Even without the stencils however, it is possible to build a model that is fully BPMN compliant by using a series of rectangles, connecting lines, and diamonds. The rectangles in this case would represent activities, the lines would represent message flows or sequence flows, and the diamonds could represent gateways for decision points. Some of the shapes would be more difficult to create than others, but with a little creativity it would not be hard for a novice to create models that communicated the collaboration between actors. There is one caution with the scratch-built approach. There is little chance that the resulting model will be compatible with an automated tool. To ensure the hand-built models will import with more advanced tools, much testing of the import mechanisms is required.

Any process notation in general can be evaluated based upon its ontological deficits, redundancies, overloads and excesses (Recker et al., 2010, p. 504). Ontological precision results when the expressiveness of the notation enables the modeler to accurately represent the real world entity in a model with maximum isomorphism. Deficiencies include redundancy (many modeling constructs map to a single ontological construct), deficit (absence of a modeling construct), overload (one modeling construct maps to many ontological constructs), and excess (modeling construct for which there is not real world ontological construct) (Recker et al., 2010, p. 504). One BPMN deficiency identified by Recker et al. (2010) was the need for expertise on the part of the process modelers (Recker et al., 2010, p. 519).

BMPN addresses notation precision challenges by providing a rich set of symbols that can be used to represent the process being modeled in a manner that eliminates deficits (defined above as the *absence* of a modeling construct). The absence of necessary constructs is one of the reasons why many organizations require a patchwork of standards in order to cover the entire analytical area. This feature-rich environment also means that there are redundancies. If one were to consider all OMG standards as part of an evaluation for ontological

redundancy, then one could consider the aforementioned overlap between Activity Diagrams and BPMN models as a redundant deficiency.

There are however, unfortunate side effects from the effort BPMN creators undertook to ensure the modeling standard was able to provide the expressive power necessary to fuel automation goals such as Business Process Execution Language (BPEL). That side effect occurs when those unfamiliar with the standard first encounter the multitude of symbols that could be used in a conformant diagram. With a little training however, this deficiency can be quickly addressed by limiting the new user models to those projects that only require collaboration between human actors. These types of models can be easily expressed with Level 1 Descriptive BPMN. As user experience with the basic elements of the modeling notation increases, the more advanced events, grouping, and data elements can be tackled.

VI. STANDARD ELEMENTS

Below is a chart that lists all of the BPMN symbols that were defined as part of the 1.x standard. These symbols include the events that help show how the process can be triggered by an entity outside the normal flow. The most common and ubiquitous of these symbols are the start and end events that typically book end a BPMN-compliant flow. Even though events are much less common in the more collaborative levels of BPMN (Level 1 & 2), the start and end events help orient a reader who is unfamiliar with the process.
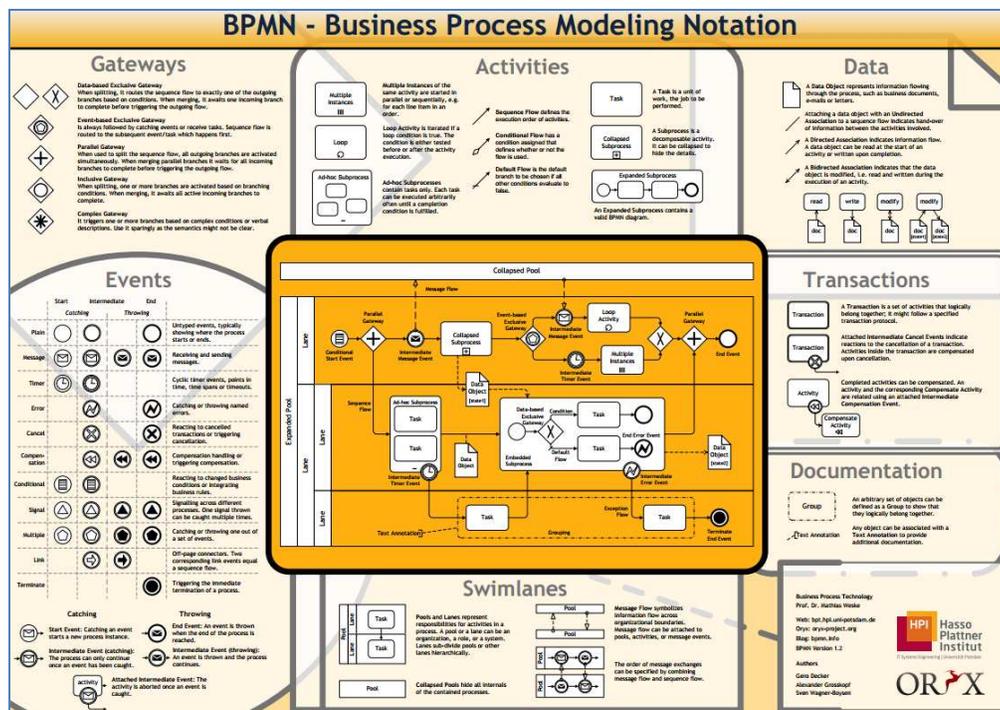

Figure 2: The BPMN reference chart for version 1.x (Hasso Plattner Istitut, n.d.).

VII. CONCLUSION

BPMN has evolved to be a compelling standard for those seeking to create process models that can be produced with the largest number of process modeling tools and consumed by the broadest range of audiences. This means interoperability has both technical and ergonomic considerations. The dual benefit of efficient creation combined with easy consumption ensures an organization will have little trouble documenting and distributing their processes. Despite the benefits and observed deficiencies with the notation itself, there are other concerns related to extracting the process information from those who execute the processes; human beings. BPMN is not a magic bullet that will instantly enable those unable to articulate their process with the ability to explain them in unambiguous terms to a process modeler. Nor will BPMN enable the process modeler to understand processes for which there is no owner, documentation, or knowledge source. It should be noted however, that no notation standard in and of itself can overcome such challenges. As a result, BPMN represents the best choice for any organization seeking to document their processes using a broadly supported standard.

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