5-2010

25R. eBPMN for Process Modeling: A design science/HIPS evaluation

Daphne Simmonds
University of South Florida, dsimmond@usf.edu

Rosann W. Collins
University of South Florida, rwcollins@usf.edu

25R. eBPMN for Process Modeling: A design science/HIPS evaluation

Daphne Simmonds
University of South Florida
dsimmond@usf.edu

Rosann W. Collins
University of South Florida
rwcollins@usf.edu

Abstract

Organizations use models to depict their strategic business processes and systems in order to provide an abstraction of the work carried out in these processes and systems. These models are drawn using different modeling notations, such as REA, data flow diagrams, and BPMN. Not only is there variation in what concepts are included in these models, but this variation leads to communication difficulties within and between organizations. The purpose of this research project is to evaluate the efficiency and effectiveness of a newly developed notation, eBPMN, which includes concepts from all widely used models and is intended to serve as a single notation for the entire organization. eBPMN extends BPMN notation (which is intended as an extensible standard for modeling business procedures) to include concepts from all modeling approaches. In the evaluation the new notation eBPMN is compared against existing notations on efficiency (time required to comprehend the model) and effectiveness (comprehension of the process modeled).

Keywords

Business Process Modeling, BPMN, Design Science

1.0 Introduction

In a prior study Domino and Collins (2009) designed the eBPMN notation (see Figure 1) based on an ontological analysis of existing process models and on core concepts included in prior ontological analyses of the constructs required for process modeling. The ontological analysis is shown, with sources, in Table 1. The table separates those constructs already explicitly supported by the BPMN standard (White, 2004), from the extension. The goal of the new notation is to provide a single notation that fulfills the original (as yet unfulfilled) vision of the BPMN to "ensure that businesses will understand themselves and participants in their businesses, and enable organizations to adjust to new internal and B2B business circumstances quickly" (www.bpmn.org). In particular the extensions include a risk assessment, accounting controls, specification of resource use, and information systems activities, which are not explicitly modeled in all notations.

The current study seeks to rigorously evaluate the eBPMN relative to existing notations. The results will indicate whether the proposed notation more **effectively** and **efficiently** represents the needs of the process modeling community. For comparison to the eBPMN those notations most popularly in use were chosen, namely the Resource Event Agent (*REA), Data Flow*

Ontological Construct	Source	Representation
Constructs Explicitly Supported in BPMN Notation		
Inputs	Carnaghan, Curtis et al.	Data objects, Events
Activities	Wand-Weber, Carnaghan, Geerts and McCarthy, Curtis et al.	Activities
Location of Activities	Carnaghan	Pools and Swimlanes
Sequence (Flow of Control)	Carnaghan	Sequence of Events and Activities
Outputs	Carnaghan	Data objects, Events
Resources	Carnaghan, Geerts and McCarthy	Pools, Swimlanes, Data objects
Operational Responsibility	Carnaghan, Geerts & McCarthy, Curtis et al.	Swimlanes
State	Wand-Weber	Event type
State Law	Wand-Weber	Sequence of Events; Groups
Event	Wand-Weber	Event
Process	Wand-Weber	Sequence of Events and Activities
Transformation	Wand-Weber	Activities
Level Structure	Wand-Weber	Subprocesses
External Event	Wand-Weber, Curtis et al.	Pools
Stable State	Wand-Weber	End event
Internal Event	Wand-Weber	Swimlanes within a Pool
Constructs Not Explicitly Supported in BPMN, but Included in eBPMN		
Objectives	Carnaghan	Description [Extension]
Related Business Risks	Carnaghan	Risk [Extension]
Accounting Transactions	Carnaghan, Rosemann and Green	Activities that incur costs are shaded [Extension]
Controls	Carnaghan	Control Swimlane [Extension]
Performance Measures	Carnaghan	Measure [Extension]
Operational Authority	Carnaghan	Control Swimlane [Extension]
System Structure	Recker et al.	System Swimlane [Extension]
Commitment	Geerts and McCarthy	Obligation [Extension]

Table 1: Modeling Constructs and Support from BPMN and Extended BPMN

Diagrams and the *original BPMN*. These are representative of notations currently used by separate functions of the organization (e.g., accounting and information systems).

This study fits into both the Design Science and the Human as Information Processing Systems (HIPS) paradigms. In Design Science (Hevner et al. 2004), an artifact is created, based on theory, and then rigorously evaluated prior to its deployment in organizations. Therefore, having developed the artifact (the eBPMN), we now seek to evaluate it prior to claiming its usefulness as a modeling notation.

The (HIPS) paradigm views a person as an information processor and the stimuli entering that persons' mind as being processed in a series of ordered stages in short term memory. Research on perception has found that in visual processing, individuals must have abilities to focus on the most relevant information in models as well as to "derive a mental model of a system structure" (Petre, 1995, p. 40). The cognitive skills brought to the task, in this case model comprehension, have significant impact on model comprehension. Diagrams have proven to be superior to text-based representations in more complex problem solving environments (Larkin & Simon, 1987). Diagrams reduce the cognitive load by shifting a portion of the information processing load to the visual perception system (Wickens & Carswell, 1995). Based on this, we evaluate the eBPMN model on this criterion: are readers **more efficient** (take less time on task) when they seek to comprehend models dawn using eBPMN as opposed to other notations?

Overall, it has been shown that optimal performance is achieved when both perceptual and conceptual performances are aided by the notation used in diagramming (Kim et al, 2000, Rogers, 1996). Diagram format has been shown to impact the perceptual performance with the diagram (Zhang, 1997). The eBPMN combines graphical elements with short process descriptions that explicitly report on process objectives, risks, measures and obligations. This is expected to aid the identification of some issues not represented in the graphical models, without requiring reading of longer, supporting text-based documents such as requirements specifications. Since this reduces the complexity of the comprehension task (less reading, one single integrated model), the expectation is that eBPMN modeling is **more effective** (readers have higher levels of comprehension).

2.0 Research Questions

In this study we evaluate eBPMN on two criteria:

Is the eBPMN notation more effective in modeling organizational processes than existing notations?

Is the eBPMN notation more efficient in modeling organizational processes than existing notations?

3.0 Experimental Design

There are several empirical tests planned: (a) a verbal protocol-based study to understand the cognitive processes of individual accountants, information systems professionals, and business managers as they review models of the same business process drawn with the eBPMN, original BPMN, REA, and DFDs; (b) an experiment that tests relative process comprehension performance across models; and (c) a field study using action research to demonstrate the usefulness of the new extended BPMN model notation with real business processes. Consistent with the purpose of evaluation in design science research, the eBPMN

Example: Process Returned Goods for a Food Products Manufacturer,

based on Carnaghan (2006)

DESCRIPTION:
The purpose of the process is to handle returns of goods from customers in a timely manner, while assuring that the amount of refunds is appropriate.

RISKS:
There are six main risks inherent in this process:
1. Goods were not purchased from the company
2. Return for credit is not authorized
3. Goods are not actually returned to the company, but credit was issued anyway
4. The credit amount is issued to the wrong customer
5. The credit amount is inaccurate
6. The return of goods process is not completed in a timely manner

MEASURES:
Time in days to process a customer return of goods
Comparison of time in days to process a return to percentage change from prior year
Accuracy of the credit issued: correct customer, correct amount
Percentage of returns processed with errors in credit amount

OBLIGATIONS:
Company policy on return of goods

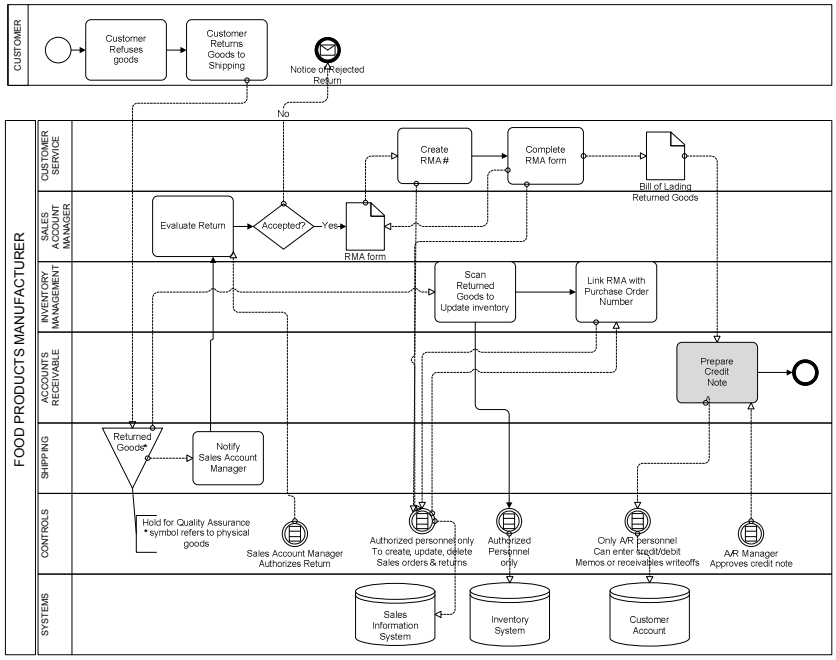

Figure 1: eBPMN Notation Example

artifact may need to be redesigned on the basis of each phase of the study. Both the process study and the variance-controlled-experiment will use the same experimental task and measures (see Figure 1. for an example for the eBPMN notation), but both are needed to enable a fuller understanding of how models are comprehended as well as to statistically test for differences in efficiency and effectiveness in model comprehension.

The experimental task is based on a previous study by Carnahan (2006), and was pretested and revised with graduate students. The dependent variables are **effectiveness**, measured by *Accuracy of Comprehension* (answers to the comprehension questions) and *Clarity of Model* (suggestion for improvement of the model); and **efficiency**, measured by *Time on Task.* The questions are shown in Figure 2. Prior to participating in the experiments, each participant will be given a spatial test in order to determine their aptitude for reasoning with diagrams. A post-experiment questionnaire will determine their satisfaction with the instructions given for undertaking the tasks. The same test and questionnaire will be given to all individuals to control for differences in **reasoning ability** and in **preparation**. The spatial tests have been pretested for refinement.

Process, Verbal Protocol Study. Sixteen working professionals, with substantial business experience in various functional areas within their organizations, and educated at, or beyond, the Bachelors Degree level, will participate. Participants will be randomly assigned to the notations. Participants will read and sign the IRB consent forms and complete the spatial ability test. This will be followed by instructions on the experimental procedures, a review of both process modeling and the notation they will be using, and instructions on performing a verbal protocol. Each will be given the experimental tasks, including reference guides for each notation and will perform a verbal protocol with no time pressure time while they look at the model and answer the comprehension and improvement questions. The protocol will be taped and then transcribed.

Variance, Controlled-Experiment. The experimental manipulation in this experiment is the modeling notation. 120 participants will be required to test eBPMN against original BPMN, DFDs, and REA models. In this experiment the procedures, tasks and measures will be the same as the previous study, with no verbal protocols while the experimental task is being completed.

Field Study. The last phase of the evaluation of the new eBPMN artifact is an action research field study. This part of the study will require the participation of an organization. The authors will teach the new method of modeling to employees, and then observe how they use (and perhaps adapt) the new notation to their process modeling activities.

Plan for Data Analysis. In the first verbal protocol study, four sets of data are collected: 1) the results of the spatial tests for analysis of variation in reasoning ability with diagrams; 2) the answers to the comprehension questions associated with the models; 3) the recorded verbal reports of subjects as they reviewed and analyzed the models and 4) the results of the post-experiment questionnaire, again for analysis of performance variation. The recorded verbal reports will reveal the details of individuals' cognitive processing as they inspect and process the models and hence show the relative ease of comprehension of the various modeling notations. For example, the transcripts will be analyzed for the number of paths taken to find the answer to a given question as well as the times spent on each question. In particular, errors in comprehension or points of confusion will be noted. The data will be analyzed to understand whether differences in spatial ability, or the notation used, or the

Questions to Answer While You are Examining the Model

(Model is shown in Figure 1.)

Accuracy of Comprehension Questions

1. What are the outputs of this process?
2. Who is involved in this process?
3. How do the returned goods get back into inventory?
4. What is the purpose of the "return merchandise authorization" (RMA) form in this process?
5. What data is retrieved from existing databases?
6. What new data is stored in the databases?
7. What costs are incurred by the company when it executes this process?
8. What is ONE risk that is controlled in this process? How is it controlled?

Clarity of Model Questions

9. In order to improve this process, what is ONE measurement that could be used, and how will it be used?
10. What is ONE other improvement that needs to be made to this process?

Figure 2: Experimental Task Questions

cognitive processes of the participants, are better explanations for the efficiency and effectiveness performance measures. In addition, since the participants are drawn from multiple functional areas, it will be possible to identify which modeling approach is better for the **whole** organization.

In the second, the controlled experiment, ANOVA and ANCOVA will be used to analyze the differences in performance between notations used, with spatial ability as a possible covariate. In the third, action research field study, the observations of the process modeling of employees prior to and after training on eBPMN will be analyzed for changes in both how processes are modeled and the efficiency and effectiveness of the models produced.

4.0 Anticipated Contributions

The primary purpose of the research project is to evaluate the new artifact, eBPMN, on the criteria of effectiveness and efficiency, in comparison with existing process techniques. If eBPMN is more efficient and/or effective, then a better way to model processes is available for organizations. Since a single modeling notation used throughout the organization is desirable, it will be especially important if eBPMN, as designed, is better for individuals with all varied functional perspectives. Successful or not, there is also potential to identify some of the relative advantages and disadvantages of each modeling notation. The process, verbal protocol study will enhance our understanding of how individuals from a variety of backgrounds comprehend process models. We will also understand where there are problems

with different comprehension tasks and with individual's spatial ability and/or cognitive processing. Such understanding can be used in future studies that seek to improve business process modeling.

This research is in progress. All experimental materials have been developed and pretested, and data collection on the process, verbal protocol study is in progress. It is anticipated that by the time of the conference, results will be available for presentation.

References

BPMN, www.bpmn.org.

Carnaghan, C. (2006) "Business Process Modeling Approaches in the Context of Process Level Audit Risk Assessment: An Analysis and Comparison", *International Journal of Accounting Information Systems* (7), pp. 170-204

Curtis, B., M.I. Kellner, and J. Over (1992) "Process Modeling", *Communications of the ACM* (35)9L, pp. 75-90

Domino, M. and R.W. Collins (2009) "A New Multi-Perspective Business Process Modeling Approach", *American Accounting Association National Meeting,* New York, August 1-5, 2009

Geerts, G. L. and W. E. McCarthy (2002) "An Ontological Foundation of the Economic Primitives of the Extended-REA Enterprise Information Architecture", *International Journal of Accounting Information* Systems (3), pp. 1-16

Hevner, A.R., S.T. March, J. Park and S. Ram (2004) "Design Science in Information Systems Research" *MIS Quarterly* (28)1, pp. 75-105

Kim, J., J. Hahn, and H. Hahn (2000) "How Do We Understand a System with (So) Many Diagrams? Cognitive Integration Processes in Diagrammatic Reasoning", I*nformation Systems Research* 11(3), pp. 284-303

Larkin, J. and H. Simon (1987) "Why a Diagram is (Sometimes) Worth Ten Thousand Words", *Cognitive Science* (11), pp. 65-99

Petre, M. (1995) "Why Looking Isn't Always Seeing: Readership Skills and Graphical Programming", *Communications of the ACM* (38)6, pp. 33-44

Recker, J., M. Indulska, M. Rosemann, P. Green (2006) "How Good is BPMN Really? Insights from Theory and Practice", *Proceedings of the 14th European Conference on Information Systems*, Goeteborg, Sweden

Rogers, E. (1996) "A Study of Visual Reasoning in Medical Diagnosis", *Proceedings of the Eighteenth Annual Conference of the Cognitive Science Society,* San Diego California, pp. 213-218

Rosemann, M. and P. Green (2000) "Integrating Multi-perspective Views into Ontological Analysis", *Proceedings of the Twenty-First International Conference on Information Systems*, December 10-13, 2000 Brisbane, Australia, pp. 618-627

Wand, Y. and R. Weber (1990) "An Ontological Model of an Information System", *IEEE Transactions on Software Engineering* (16)1, pp. 1281-1291

White, S. (2004) "Introduction to BPMN", *IBM Report*

Wickens, C.D. and C.M. Carswell (1995) "The Proximity Compatibility Principle: Its Psychological Function and Relevance to Display Design", *Human Factors* (37), pp. 473-494.

Winn, W. (1994) "Contributions of Perceptual and Cognitive Processes to the Comprehension of Graphics", in *Comprehension of Graphics*, W. Schnotz and R. Kulhavy, Eds., North-Holland, Amsterdam