

MODELING WORK PROCESSES AND SOFTWARE DEVELOPMENT

Notation and Tool

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Abstract: Process modeling are becoming more essential to the activities of acquisition and development of systems. There are a number of possible notations and tools for process modeling, and sometimes it isn't an easy choice. This papers try, through research in a real environment, identify selection criteria and recommend the most appropriate notations and tools for process modeling.

1 INTRODUCTION

The process modeling, over the last decade, has become an important mechanism for understanding the dynamic behaviour of organizations. This mechanism appears to be superior to techniques previously used by professionals in information systems, and can increase the success of technology implementation projects in dynamic environments (Green & Rosemann, 2000). Experts in the process engineering field and in the area of information technology, benefit from a better understanding of organization's processes. The conceptual modeling of these processes facilitates the development of appropriate software to support that process (Agular-Savén, 2003).

In fact, the modeling process is essential to represent complex systems, being of great importance in defining the rules of integrated information systems to business processes. Actually, the process modeling is the key element to achieve high quality models that can support the creation of effective information systems (Ortiz-Hernández, Nieto-Ariza, Estrada-Esquivel, Rodríguez-Ortiz, & Montes-Rendon, 2007). Bargis (Bargis, 2008) agrees that the current software is more than mere artifacts. According to him, it is a complex phenomenon techno-social, and that complexity just can be addressed through the modelling process, as the basis of a model-centric software development processes.

Thus, even before the research in modelling and software development processes themselves, this paper seeks to identify a notation for the wide process modeling, which can be easily understood by humans, and yet, which has the potential to generate information processable by machines.

2 MODELING NOTATIONS

There are several notations or methods available for modeling processes, and many other tools that support these notations (Gartner Group, 2008). Some of the tools support more than one notation. This work focuses on four notations of process modeling, considering its relevance to the topic or its consolidation in the market and in academia. The notations are: ARIS BPMN, SPEM and IDEF0.

The presence of the ARIS notation in this work is justified by its wide use, having been the object of several studies (Araujo, et al., 2004) (Scheer, 2003) (Santos Jr, Almeida, & Pianissolla, 2008) (Souza, et al., 2009). In addition, consecutive surveys by the Gartner Group indicated that notation as the market leader (Gartner Group, 2008), which can be seen in Figure 1.

The notation ARIS (Architecture for integrated Information Systems) is a framework for enterprise modeling. This notation can describe your organization's information architecture and integration through its processes, and different organizational views can be described. To

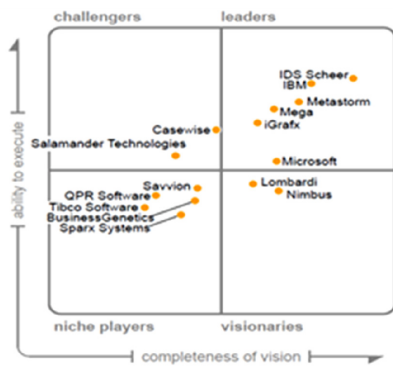


Figure 1: Mains tools of process mapping (Norton, Blechar, & Jones, 2010).

visualize the workflow diagrams are used Event-Driven Process Chain, or simply EPCs, diagrams are used. Besides the description of activities and its flow, the notation defines roles or profiles, and information produced and used in the process (Santos Jr, Almeida, & Guizzardi, 2010). The main elements of an EPC are seen in Table 1.

Table 1: Elements of the EPC.

Element	Symbol
Event	
Function	
Conectors	
Flow	
Interface	

Another important notation is the IDEF0. It was prepared at the request of the Air Force in the 1970s, and built from a well-defined graphical language known as SADT (Structured Analysis and Design Technique). Widely used in the United States and some European countries, the IDEF0 allows us to represent activities, flows, support resources, and controls that take action on the activity. The method is basically composed of boxes and arrows, and the location of the box where the arrow connects indicative of its kind: input, output, or resource control (Soung-Hie & Ki-Jin, Designing performance analysis and IDEF0 for enterprise modelling BPR, 2000), as can be seen in Figure 2.

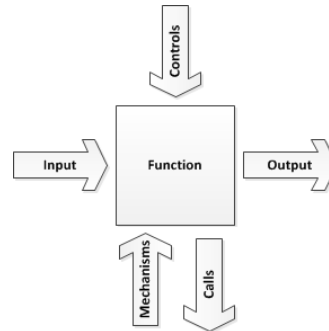


Figure 2: Meaning of the elements of the IDEF0.

An IDEF0 model consists of a hierarchical series of diagrams that show progressive levels of detail, expanding knowledge about the process and describing their functions and interfaces within a system. The contribution of the modeler is important. He must have an abstract view of the model, which can be difficult in large systems (IEEE, 1998) (Soung-Hie & Ki-Jin, Designing performance analysis and IDEF0 for enterprise modelling in BPR, 2002).

The SPEM (Software and Systems Process Engineering Metamodel), in turn, was considered in this study because it is a notation created for the domain of software development field. It was adopted by the OMG (Object Management Group) in 2002 and since then it has become an official standard of the organization. It is a meta-model that defines the standard stereotypes UML (Unified Modeling Language) for modeling software processes. In fact, SPEM is a network of concepts and relationships that are expressed by existing stereotypes in UML, but they could also be described by any sufficiently expressive language, perhaps even English, Spanish or Portuguese (Gonzales-Perez & Henderson-Sellers, 2007). Some of the stereotypes can be seen in Table 2 (Abdala, Lahoz, & Sant'Anna, 2003).

Another important notation is the Business Process Model and Notation (BPMN). Business Process Management Initiative (BPMI) published specification for version 1.0 in May 2004, joining the OMG in June 2005 with the goal of building a standard process modeling to become the main resource in the field. Currently, BPMN is in its version 2.0 (OMG, 2010).

The model BPMN defines a process diagram that is based on flow charts (flowchart) for the description of work operations. This is a graphical network composed mainly of activities (work) and arrows (flow). The purpose of the notation is to be easily understood, but also able to generate information for the execution environments of

Table 2: Main stereotypes of SPEM.

Element	Symbol
WorkProduct	
WorkDefinition	
Guidance	
Activity	
ProcessPerformer	
ProcessRoler	
Documento	

processes, for example, through Business Process Execution Language (BPEL). In fact, it is part of the design of the model to create a bridge between the work processes and the implementation of these processes (White, 2004).

While BPMN has a wide range of representation elements, a few elements are sufficient to represent most of the work processes, which includes the processes of software development. These elements are presented in Table 3.

Previous works are related to this research. For example, Macedo and Schmitz (Macedo & Schmitz, 2001) sought to find the best tool for modeling software processes, but with the goal to tie in the software development and the business processes. They evaluated the tools Aris Toolset and Provision Workbench. They considered aspects such as the functional architecture, process modeling method, level of detail of procedures, ease of use of the editor, semantic checker, among others. However, there was no score for these aspects and their work does not recommend a tool. Still, the notations were not considered further.

Similar work (Benedictis, Amaral, & Rozendfeld, 2003) conducted a survey of notations Aris and IDEF0. Tools that would support these notations were also evaluated. The purpose of this research would identify the appropriate notation and tool for modeling work processes with emphasis on product development. In terms of tool, they analyzed the Aris Toolset, Microsoft Visio and Microsoft PowerPoint. After reviewing the two notations and three tools, the paper concludes by making only

general considerations. We must also consider that Microsoft Visio and Microsoft PowerPoint are general purpose tools and not specifically for process modeling.

Table 3: BPMN object model.

Element	Symbol
Event	
Activity	
Gateway	
Sequence flow	
Message flow	
Association	
Pool	
Lane	
Data	
Group	
Annotation	

3 EVALUATION OF NOTATIONS

The research objective was to identify a notation that is understandable by humans and executable by machines. An experiment was conducted in a real environment, the Oswaldo Cruz Foundation, an important public health research institution in Brazil. This was done in two steps: 1) an analysis performed by process modelling professionals, 2) an analysis by regular users, from several areas of the organization.

With the goal of using the same framework for analysis both by professionals and regular users, we chose a generic process as an example. The hypothetical process used was the issue airline

tickets, originally described in Portuguese.

The notations considered in this study were evaluated by four process modelling professionals. For the evaluation we established a set of criteria, which consolidated proposals from other studies (Macedo & Schmitz, 2001) (Benedictis, Amaral, & Rozendfeld, 2003), and added criteria in order to broaden the scope of the research. The criteria can be seen in Table 4. Each modeler built a model from the reference process, using a different notation, namely ARIS, BPMN, SPEM and IDEF0.

Table 4: Criteria for analysis of models by the team of modelers.

Criterion	Detailing
It has well-defined syntax	The objects are related through rules that must be obeyed, then, the method sets the proper connections between the objects.
It has well-defined semantics	There are specific objects that have different meanings, and cannot be used for a different representation than that for which it was created.
It is widespread	The method is widely used in academia and / or marketing.
It is easy to learn	The method is easy to learn and can be understood without further knowledge and skills by the user.
It is easy to read and understand	The processes modeled based on the method can be easily understood by most people, even with little or no prior training about the method.
Represents activities	Activities performed by human beings are representable with the method.
Represents information	Information, data or documents can be represented with the method.
Represents resources	Resources such as technology, systems, and others, can be represented with the method.
Represents integration between processes	The coupling between processes, ie the integration between them, can be represented with the method.
Represents the actors who perform the activities	People, positions and areas (departments) can be represented with the method, and related to the activity they perform.
Represents the execution of an activity for more than an actor	The same activity may be related to two performers at the same time.
Represents system requirements	System requirements that would support an activity can be represented, or at least indicated with the notation ..
It is extensible	The notation provides its own extension by adding new objects.

After the process modeling an interview was conducted with modelers where each one presented the model built, spoke of the difficulties and ease of use, and responded to questions raised by the other modelers. Then, each modeler has a complete evaluation of the four models considered by completing the evaluation sheet.

This evaluation was performed using a Likert scale, in which the responses for the items vary according to degree of intensity, and the categories are ordered and equally spaced with the same number of items in all categories (Alexandre, 2003). The evaluation was conducted at five levels, namely: 1 - Totally disagree, 2 – Mostly disagree mostly, 3 - I'm not sure, 4 - Mostly agree, 5 - Totally agree.

Table 5: Evaluation of models according to the criteria.

Item	ARIS/EPC				BPMN				IDEF0				SPEM				Average
	Especialista 1	Especialista 2	Especialista 3	Especialista 4	Especialista 1	Especialista 2	Especialista 3	Especialista 4	Especialista 1	Especialista 2	Especialista 3	Especialista 4	Especialista 1	Especialista 2	Especialista 3	Especialista 4	
It has well-defined syntax	5	5	5	4	5	5	5	5	4	4	5	5	3	2	3	3	4,25
It has well-defined semantics	5	5	5	5	5	5	5	5	3	2	4	4	4	2	4	3	4,13
It is widespread	5	5	5	5	5	5	5	5	4	3	3	4	2	3	3	4	4,13
It is easy to learn	5	5	4	5	5	5	5	5	3	1	3	3	2	1	2	2	3,50
It is easy to read and understand	4	4	5	5	5	5	5	5	3	2	2	4	2	1	3	2	3,56
Represents activities	5	5	5	5	5	5	5	5	3	3	3	4	4	3	3	2	4,06
Represents information	5	5	5	5	5	5	5	5	3	4	3	3	4	3	3	3	4,13
Represents resources	5	5	5	5	5	5	5	5	3	4	3	3	5	3	3	3	4,19
Represents integration between processes	5	5	5	5	5	5	5	5	4	4	3	4	3	4	3	3	4,38
Represents the actors who perform the activities	5	5	5	5	5	5	5	5	3	4	3	3	5	4	4	4	4,38
Represents the execution of an activity for more than an actor	5	5	5	5	4	4	4	4	3	4	4	3	4	4	4	4	4,13
Represents system requirements	5	5	5	5	5	5	5	5	3	3	3	3	5	3	3	3	4,13
It is extensible	5	5	5	5	5	5	5	5	3	3	2	3	3	3	3	3	3,94
	4,9	4,9	4,9	4,9	4,9	4,9	4,9	4,9	3,3	3,2	3,2	3,5	3,6	2,7	3,2	3	4,1
	4,92				4,92				3,29				3,13				
	ARIS Average				BPMN Average				IDEF0 Average				SPEM Average				

In Table 5 is possible to make two observations - how each criterion is met in overall by the models, and how close the models are to meet all criteria. In the analysis the averages are calculated per criterion, horizontally, the average per modeler, vertically, and the overall averages for the tool, which is the overall average for that particular notation.

At this point the work indicated a tie between ARIS and BPMN notations, with a score very close to the maximum possible. The IDEF0 and SPEM models were lower the previous, and team of modelers were not inclined towards either of the two best placed notations.

Aiming to broaden the search and check the level of understanding of the models that were tied in first place, another survey was conducted. This time, involving 50 people from different areas of the organization without any formal training in process modeling. The participants secretaries, people in the area of HR, Purchasing and other general administrative professionals.

The research was composed of referral process in both modeled in BPMN notation as ARIS, the actual process of reference in Portuguese, and a questionnaire to indicate which of the two models

would be easier to understand. There was an advantage on the ARIS over BPMN, as in Figure 4.



Figure 3: Research models of understanding with people from different areas.

After this stage the BPMN notation is now considered the most appropriate in terms of human understanding, and the next steps of research focused on this notation, since the aspect of human understanding was a working premise. Moreover, unlike the ARIS notation, BPMN notation is an open standard from the OMG and has the support of major players in this market, including IBM, Oracle, SAP, Unisys and even IDS Sheer, owner of the notation and tool ARIS.

4 EVALUATION OF TOOLS

Considering the advantage gained by BPMN rating, the work continued by evaluating tools available in the Brazilian market that would support this notation. The tools analysis phase had the support from a group of six modeling processes professionals, including the original group of four professionals and two modelers who joined the work in this phase.

Initially we defined the desirable characteristics, ie the criteria to be considered in evaluating the tools. Criteria used in other similar works, such as (Benedictis, Amaral, & Rozendfeld, 2003), and (Recker, 2010), formed the basis of the criteria of this work. The criteria are presented in Table 6.

Table 6: Criteria for analysis tools.

1	Tool Requirements
1.2	Language in native language (Portuguese - BR)
1.3	Enables cooperative work
1.4	Integrated repository for models
1.5	Versioning allows
1.6	Allows WEB Publishing
1.7	Allows export to other tools via XPD.L
1.8	Allows integration with tools via BPEL Workflow
1.9	Allows for method validation
1.10	Allows to query the database for ontological entity

Table 6: Criteria for analysis tools (Cont.).

1.11	Navigation between models of different levels
1.12	Additional attributes for model objects
1.13	Allows the use of more than one modeling notation
1.14	Allows to create new custom objects
1.15	Allows to add hyperlinks to other documentation
1.16	Allows to create filter with the set of objects you wish to use
2	Additional Support
2.1	There are training courses
2.2	There are virtual communities of support
2.3	There are publications available to help and support

The work used the concept of relevance, in order to equalize the degree of importance among different criteria. With the exception of the criterion for integration with workflow tools via BPEL, which received a score of 4, the remaining criteria classified as requirements of the tool received a score of 2. The criteria for receiving additional support scored a 1, because they are less relevant.

The tools considered were those found in the Brazilian market: Mega, Tibco, QPR, QPR Express; BizAgi Free; BizAgi Express; Free Aris, and Aris complete. For those that had free options, these have been independently assessed.

Modelers were divided into two groups, each group responsible for examining a set of tools. Then, the groups met to present and discuss the results, generating a consensus evaluation. The evaluation result can be seen in Table 7.

Table 7: Analysis of tools according to the criteria.

1	PERO	MEGA	TIBCO	QPR	QPR EXPRESS	BIZAGI FREE	BIZAGI EXPRESS	ARIS FREE	ARIS FULL
1.2	2	2	2	6	2	6	6	2	6
1.3	2	6	6	6	2	2	6	4	6
1.4	2	6	6	6	2	2	6	2	6
1.5	2	2	6	6	2	2	2	2	6
1.6	2	6	6	6	6	6	6	2	6
1.7	2	4	6	6	2	6	6	2	4
1.8	4	8	4	12	4	12	12	4	12
1.9	2	4	6	6	2	6	6	6	6
1.10	2	6	6	6	2	2	4	2	6
1.11	2	4	4	4	2	2	4	2	6
1.12	2	6	6	6	6	6	6	6	6
1.13	2	2	2	2	2	2	2	6	6
1.14	2	4	4	6	4	2	4	2	6
1.15	2	4	4	4	2	4	6	6	6
1.16	2	4	0	4	2	2	4	2	6
Requirements	4,53	4,8	5,73	2,8	4,13	5,33	3,33	6,27	
2	PERO	MEGA	TIBCO	QPR	QPR EXPRESS	BIZAGI FREE	BIZAGI EXPRESS	ARIS FREE	ARIS FULL
2.1	1	2	2	3	1	3	3	3	3
2.2	1	1	2	3	3	3	3	2	2
2.3	1	2	2	3	3	3	3	3	3
Additional	1,67	2	3	2,33	3	3	2,67	2,67	
Overall	3,1	3,4	4,37	2,57	3,57	4,17	3	4,47	

According to the analysis, and taking into account specific criteria requirements tool, the tool ARIS Full (complete and paid) received the highest average score. Considering only the criteria for additional support, tools QPR, BizAgi Free, and BizAgi Express were tied in the lead. In the final average, the tool ARIS Full received the highest score.

By observing the average of fulfilling the criteria for the tools it is possible understand what criteria the manufacturers are more concerned with delivering. The three criteria are best placed: 1 - additional attributes for objects in the model, 2 - WEB publication of the model in 3 - validation mechanisms for the model.

Another observation is that the average final score of the paid tools is not so far off compared to the average final score of the free tools. This result may indicate a strengthening of the free versions.

There are other factors that may be considered on tools. For example, the tool QPR was only a tenth behind the complete ARIS, which may recommend its use. Still, cost issues may recommend using a free tool such as BizAgi free, which scored even higher than some paid tools.

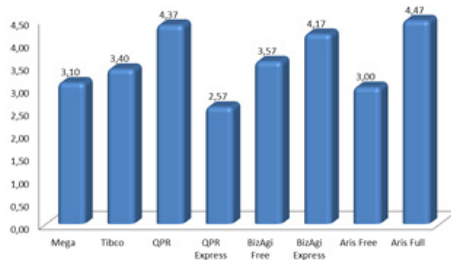


Figure 4: Average final comparative tools.

5 CONCLUSIONS

After the performance modeling and analysis by a group of experts, followed for an analysis by regular users, the research points to the BPMN notation as a solution more understandable by humans and has potential to be translated into machines. In addition, regarding tools, the results indicated the complete ARIS, the QPR Express and BizAgi, the latter free.

An important contribution of this work was to consider notations and tools whose relationship has yet been little explored in previous works. Still, we considered only specific tools of process modeling. Another contribution was the structuring of criteria from previous work, and even the addition of specific criteria to the objectives covered by the study. Finally, the recommendation of a method and

a specific tool, and provides more concrete basis for the advancement of research in this area.

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