A Comparative Study of Business Process Management Tools based on Open Source Software and a Commercial Reference

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ABSTRACT

This paper examines Business Process Management tools with a multiple attributive assessment framework based on the utility ranking and AHP method. It supplies a comprehensive list of eligible criteria for the assessment and provides a comparative analysis in terms of their features and development focus in relation to a commercial market leader (ARIS). Considering the age of the assessed OSS projects, their functionality for BPM is already impressive. The user innovations surfaced from the OSS tool analysis show that tools concentrate on model driven business process architectures. In the OSS world, the process and workflow models are seen as unified models. In the commercial world, workflow models are often referred to as an abstraction of the business process models concentrating on steps that can be automated. This work further supports the view at our research institution that OSS tools can already be used effectively in the class room in conjunction or even as alternative to commercial ones.

Keywords: Business process management (BPM), process modeling, workflow modeling, open source software (OSS), ARIS and AHP.

INTRODUCTION

In today's dynamic business environment effective, efficient yet flexible business processes offer the foundation for competitive enterprises [24]. Business processes need to be designed, enacted with ideal IT support and controlled in terms of a wide number of requirements. Hence, business process management (BPM) is holistic task supporting the whole lifecycle of business processes. This life cycle describes the various phases in support of business processes (see Figure 1). The design phase concentrates on the analysis and (re-)design of processes. In the set-up or implementation phase the designs are implemented by configuration of a process oriented information system (e.g. workflow systems or even a traditional ERP implementation). After set-up, the enactment phase allows the operational execution of business process definitions in terms of business process instances. The business processes are executed, their instances using the implemented system. In the monitoring phase, the operational processes are analyzed to identify bottle-necks, errors, etc. with the ultimate goal to improve business process performance. The findings from the monitoring phase are forwarded into the design phase initiating a new cycle for continuous business process improvement.

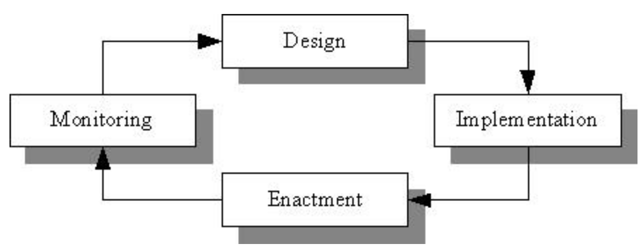

Figure 1. The Business Process Management lifecycle

According to this lifecycle approach we define BPM as follows:
BPM summarizes all activities including methods, techniques, and computer software to design, implement, enact and monitor business processes involving resources such as humans, organizations or organizational units, applications, and any information available within or outside organizational boundaries.

Other similar definitions restrict business processes to operational processes [25]. This implies that processes at the strategic level or processes that cannot be made explicit are excluded.

A wide number of different systems exist that support BPM. They can originate from different application domains such as from Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) or from Enterprise Application Integration (EAI). However, also sophisticated tools exist for the management of business processes such as tools from IDS Scheer (ARIS Product Family). While all the mentioned areas were traditionally sourced from commercial providers, the open source software (OSS) community has achieved to develop a number of alternative tools. OSS projects can be labeled as user innovations (von Hippel 2005). This term refers to innovations produced by users, which expect to benefit from using a product or service, as opposed to a manufacturer, who expects to benefit from selling it. The main reason for users developing innovations is "sticky" information concerning their needs and context of use, with stickiness referring to high costs for transferring this information due to tacit ness or other reasons [23]. When it is too difficult or costly to transfer this information, the focus of problem solving might shift to the users. This means that they develop their own solutions that best fit their exact needs. Especially lead users, which are defined at being at the edge of an important trend and having high expected benefits from a solution, have been shown to produce attractive innovations [22].

This paper reports on findings from a tool oriented analysis of business process management that considers a wide range of open source tools and a commercial reference product (ARIS). It supplies additional findings, such as the applied assessment criteria list comprising measurements and a weight profile for aggregation purposes. It shows the development direction of user driven BPM applications. Hence, the findings of this article should provide valuable insights for business practice and educational facilities in their search for business process management tools.

RESEARCH GOALS

This research seeks to

1. define a comprehensive list of eligible criteria for the assessment of business process management tools,
2. and to provide an assessment of open source software tools in terms of their features and development focus in relation to a commercial market leader.

Regarding (1), the selection of a particular BPM tool is an important step in many BPM projects. Tools have emerged from different focus areas promising to support all or specific stages of the BPM lifecycle presented in Figure 1. Business process modeling has a long tradition, and a variety of tools are offered in the commercial market place. The Gartner Group provides a specific analysis of the market under the term business process analysis [2]. Also tools from the workflow management or the business monitoring sections have emerged that are promoted as BPM tools. This research project emphasizes analyze and design of business processes. Most central criteria from the sub-sequent BPM stages (e.g. process implementation and monitoring features) are, however, also included. Hence, we recognize the dependent nature of BPM in the proposed lifecycle.

Regarding (2), this research reports on the BPM utility of open source software as compared to commercial leaders. The goal of this paper is to not elaborate on BPM OSS usage in companies. OSS projects are user centric innovations. This feature makes them a very interesting research subject. New or proposed features provided by OSS reflect the need of user organizations. Observations of the development focus of different OSS projects in the BPM domain should provide valuable insights into the current needs of BPM. In addition, OSS tools have proven to be successful in other fields of application and are increasingly used in the process and information aware areas such as for data mining [27] and data management [11]. This research assumes that it is only a matter of time until OSS can challenge commercial market leaders in the area of BPM.

METHODOLOGY

To support the assessment and comparison of BPM tools, this article is supported by two different multiple attributive assessment methodologies. First, the utility ranking approach [26] is used in terms of single-attributive measurements and their transformation in an overall, uniform scale. Second, the analytical hierarchy process (AHP) is used to derive a weight profile for the considered attributes [15, 16]. These two approaches allow us to aggregate all measurements to achieve a final ranking of tools based on simple-additive weighting. Both frameworks are based on additive value models. The decision maker tries to maximize a quantity called utility or value. This postulates that all alternatives may be evaluated on a single scale that reflects the value system of the decision maker and his preferences. To generate this super scale, multiple single-attribute value functions are aggregated, most regularly by a simple additive procedure.

Hence, single-attribute value functions are needed. The attributes were identified in two steps. The first step is a bottom up approach to find requirements identified in literature that can be used as criteria in the tool assessment. The second step consists of a mapping with other criteria lists used in surveys to ensure completeness and validity. The measurements for each tool were based on the installed system, the documentation (help system, forum, homepage, etc.) and available literature. Two different scales were used for the measurements: school grades (1 "very good" to 5 "very bad") and binary (Yes/No). For each criteria assessment a textual statement was added for every system.

The AHP application for weight definitions needed clustering of attributes for the AHP goal hierarchy. This clustering was achieved through a card sorting approach.

An expert group (two BPM university lecturers, one practitioner, one researcher) was confronted with the criteria. In this application context, the card sorting was only applied once instead of the many needed for usability engineering. The expert group that clustered the criteria needed to be reminded in terms of the maximum of 10 attributes per cluster. We reminded the group to seek for homogeneous, semantically clear and independent clusters. As a next step, the AHP pair wise comparisons on cluster level and attribute level were undertaken. After successful consistency tests (only one revision of one table was necessary), the Saaty's Eigenvector method was immediately used to calculate the according weight profiles.

Finally, the value aggregation per alternative was undertaken by a weighted sum of single-attribute value functions. The overall suitability of each alternative is thereby calculated by averaging the score of each alternative with respect to every attribute with the corresponding importance weighting.

SELECTION OF CRITERIA

Bottom up search

Selection criteria for BPM cover a wide range of aspects. Besides organizational, economical, and technical aspects in particular the integration within the given IT infrastructure, the features of the used modeling language e.g. in terms of expressive power, are important criteria. Also features in terms of process enactment, monitoring and feedback for controlling process performance are prominent needs. Next to processes, personnel and organizational structures of the enterprise need to be taken into account. A well-defined semantics of the process language is considered as another central role during product selection [25]. Other key areas of reference were the papers from [1, 7, 9, 10, 12-14, 18, 21]. The mentioned areas only cover parts of the attribute range. The needed features were extensive and 41 criteria were initially selected. They are given with the results of the applied AHP approach later in the paper (Table 2).

Validation of criteria with other studies

The initial list of criteria was mapped with four different studies from Gartner Research [6], BPMInstitute.org [17], Ten Pillars of BPM / Hurwitz Group [8], and Upside Research [5]. Based on the undertaken mapping the following criteria were added or amended:

- Check in/Check out (CVS)
- Associations (actors, roles, organizational units, other)
- Process development status
- Business Rules
- Triggers/Wait-Activities
- Support for reference models
- Authorization concept

Consequently, the final list of criteria comprises 51 elements (see Table 2).

SELECTION OF TOOLS

Commercial tool reference

ARIS from IDS Scheer was selected due to its market leadership as reported in the Gartner Magic Quadrant for Business Process Analysis Tools, 2006 [2]. In this report IDS Scheer's tools were placed at the top most position with regard to both dimensions „ability to execute“ and „completeness of vision“. This indicates that IDS Scheer provides the tool with greatest ability to execute and the best completeness of vision. The tool is also available to our research institution in terms of a free campus license for educational purposes. This situation justified the choice of ARIS as commercial reference. Two different set-ups of ARIS were considered as reference points: The complete ARIS Product Family reflecting all features of ARIS and the Design Platform of ARIS only (which includes the analysis and modeling requirements of BPM only).

OSS tool selection

The selection of OSS candidates was based on the most popular and largest OSS development platform sourceforge.net [19]. It provides free hosting with a centralized resource for managing projects, issues, communications and code. Sourceforge.net promises reproducible (future research) and statistical (project metrics) analysis of large number of comparable projects. These features justified its usage for this study. Also other scientific work relied on sourceforge.net as project source for analysis of OSS features, e.g. a recent paper on the success of open source projects [4]. By the end of 2007, sourceforge.net administered 164.955 registered projects for 1.752.024 registered user. Selected popular projects are „Gnome“ (Desktop Environment), "Firebird" (Database application), "eMule" (P2P client) or "BitTorrent" (Tool for distributed download).

As search criteria to find BPM tools at Sourceforge ("advanced search") we used:

- „Business“ AND „Process“ AND „Management“
- in either fields: „Name“ OR „Description“

This was followed by an analysis of the project's targeted application areas. The resulting hits comprised 30 projects that were using business process design in some way to accomplish business tasks. Hence, all the resulting projects are considering BPM to some extent. The final tools list had to comply with a number of additional criteria for a sensible comparative study. The relevant OSS tools for the multiple attributive assessments needed an explicit focus on business process management with or without workflow functionalities. They had to be suitable for end user application which was measured by their reported support for the Sourceforge.org roles "User" or "Other audiences". Hence, no pure development tool for technical staff only was selected. Next, the project needed to be on a development stage equal or above the beta stage. Finally, we wanted to exclude micro projects. The number of members had to greater than one. This sufficed as filter criteria. The list of

30 projects was therefore reduced to five projects that are suitable for the following multiple attributive assessments. The final resulting list of OSS tools can be seen in Table 1. As can be seen these projects are all active and were registered between 2003 and 2004. It should be noted jBpm.org has its own web site resulting in a low number of project web hits and forum posts. However, the source code and binaries can be downloaded from Sourceforge.org for every project.

Name	Focus	Development Status	Members	Activity	Registered
jBpm.org	BPM (inkl. WF)	5	41	99,44%	02.01.2003
uEngine BPM	BPM (inkl. WF)	5	16	99,61%	18.12.2003
YAWL	BPM (inkl. WF)	4	15	98,33%	15.07.2004
AnaXagora	BPM (w/o WF)	5	7	95,73%	13.10.2004
RUNA WFE	BPM (inkl. WF)	5	20	99,86%	26.11.2004

Table 1. Resulting final OSS tool list (5 projects)

uEngine offers an end user centric BPM tool. It offers a so called technical abstraction for easy process design. This should help non-technicians to adapt business process models. It is very adaptable and strongly supports the possibility to extend the expressiveness of the modeling language. YAWL is workflow and BPM system registered by two universities (Eindhoven University of Technology, Queensland University of Technology) and proposes a modeling language based on a petri-net extension. The extension was motivated by the shortcomings of petri-nets to cover a comprehensive list of workflow design patterns [20]. jBPM also offers a proprietary modeling language in its process designer that saves the models in JPDL. The visual designer is embedded in eclipse as plug-in. jBpm supports the enactment of processes with its proprietary „Java Process Definition Language (jPDL)“ or even with the „Business Process Execuation Language“ [3]. RUNA's modeling language is based on the UML notation. It also saves the models in JPDL (from jBpm) and uses the sophisticated process engine from jBpm. In terms of AnaXagora, a multiple module OSS project was selected that also considers a BPM module. The BPM solution is oriented around the needs of knowledge management.

MULTIPLE ATTRIBUTIVE ASSESSMENT AND AGGREGATION

Results from AHP

Table 2 shows level 2 and 3 from the used AHP hierarchy after the clustering of attributes by the expert group. Level 2 represents the clusters. 10 different clusters were created with 51 underlying single attributes on level 3. w_1 are the weights distributed within each cluster. If weights from the ten different weight vectors w_1 are multiplied with the weight of the corresponding cluster, we receive w_2, which represents the overall weight vector.

The results of the pair wise comparisons for level 2 (clusters) can be seen in Table 3. The comparison matrix is the square matrix on the right (from C1 to C10). We have ten elements for comparisons (n). All values on the main diagonal are 1. The values below the main diagonal are automatically calculated from the values above (reciprocals). EV is the Eigenvector belonging to the maximal Eigenvalue (λ_{max}). The normalized eigenvector EV_{no} represents the resulting weighting vector for the clusters. The consistency test revealed a consistency ratio (CR) of 3 % which is far below the consistency threshold of 10%. Every ratio above this threshold indicates an inconsistent matrix. CI and RI are intermediate results for calculating the more important CR. For a complete introduction into AHP, we want to refer to [15, 16].

Gew	Cluster	EV	EVno	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
5,17%	System architecture	0,14	0,05	1,00	0,33	0,50	1,00	0,25	2,00	0,33	1,00	0,50	1,00
18,33%	Didactic aspects	0,49	0,18	3,00	1,00	2,00	3,00	1,00	4,00	2,00	3,00	2,00	4,00
15,38%	Effectiveness & Efficiency	0,41	0,15	2,00	0,50	1,00	4,00	0,50	4,00	2,00	4,00	2,00	4,00
5,42%	System configuration	0,14	0,05	1,00	0,33	0,25	1,00	0,20	2,00	0,25	2,00	0,50	2,00
21,49%	Modeling methodology	0,57	0,21	4,00	1,00	2,00	5,00	1,00	5,00	2,00	4,00	3,00	4,00
3,00%	Process implementation	0,08	0,03	0,50	0,25	0,25	0,50	0,20	1,00	0,25	0,50	0,25	0,50
13,40%	Associations	0,36	0,13	3,00	0,50	0,50	4,00	0,50	4,00	1,00	3,00	2,00	4,00
4,54%	Security & Compliance	0,12	0,05	1,00	0,33	0,25	0,50	0,25	2,00	0,33	1,00	0,50	1,00
9,14%	Standards	0,24	0,09	2,00	0,50	0,50	2,00	0,33	4,00	0,50	2,00	1,00	3,00
4,13%	Reporting & Monitoring	0,11	0,04	1,00	0,25	0,25	0,50	0,25	2,00	0,25	1,00	0,33	1,00
		λ_{max}	n	CI	RI	CR							
		10,34	10	0,04	1,45	0,03							

Table 3. Cluster comparison matrix (level 2, one table)

Cluster	Attribute	w_1	w_2
Associations (w=13%)	Association of actors/persons	40%	5,3%
	Association of roles and posts	40%	5,3%
	Association of other resources	12%	1,6%
	Association of organisational units	8%	1,1%
Didactic aspects (w=18%)	Documentation quality	25%	4,6%
	GUI quality	23%	4,2%
	Help system	12%	2,2%
	Access to saving	11%	2,0%
	Optical attractivity (colors, symbols, etc.)	8%	1,4%
	Apropriate information density	6%	1,2%
	Access to printing	6%	1,1%
	Consequent mouse and keyboard support	5%	0,9%
	Entry barriers	4%	0,7%
Effectiveness & Efficiency (w=15%)	Business user support	18%	2,8%
	Check-In/Check-Out	17%	2,6%
	Re-use support	17%	2,6%
	Model repository	17%	2,5%
	Reference models	15%	2,3%
	Process development status	9%	1,3%
	Collaboration support	8%	1,2%

Cluster	Attribute	w_1	w2
Modeling methodology (w=21%)	Split/Joins with synchronisation	34%	7,2%
	Embedded processes (handling complexity)	22%	4,8%
	Projections/perspectives	17%	3,7%
	Uniform process- and workflow modeling	10%	2,2%
	Triggers/wait-activities	7%	1,6%
	Method filtering (handling complexity)	6%	1,3%
	Uncertainty and flexibility	3%	0,6%
Process implementation (w=3%)	Model driven implementation	50%	1,5%
	Workflow support	50%	1,5%
Reporting & Monitoring (w=4%)	Reporting power	54%	2,2%
	Performance reporting	30%	1,2%
	Process monitoring	16%	0,7%
Security & Compliance (w=5%)	Syntactic checks	44%	2,0%
	Simulation and testing	32%	1,4%
	Business Rules	16%	0,7%
	Access rights	9%	0,4%

Cluster	Attribute	w_1	w_2
Standards (w=9%)	UML	27%	2,5%
	BPMN	25%	2,3%
	XML	20%	1,8%
	SQL	10%	0,9%
	Development (Java, etc)	9%	0,8%
	BPEL	6%	0,5%
	Other	4%	0,3%
System architecture (w=5%)	Graphical user interface	42%	2,2%
	Webplattform	29%	1,5%
	Single IDE	15%	0,8%
	Plattform independence	11%	0,6%
	Scalability	4%	0,2%
System configuration (w=5%)	Programming efforts	53%	2,9%
	Installation/implementation	33%	1,8%
	Integration (interfaces, adaptors)	14%	0,8%

Table 2. Clusters, their criteria and weights from AHP

The same procedure was applied to the comparisons needed on the next level 3 (“attributes”) for ten different tables. However, the normalized eigenvector for these cases represents the weighting vector for the attributes within the cluster. To calculate their overall weight assumed independency and multiplied the weight of the attribute with the weight of the corresponding cluster to arrive at the final attribute weights.

Final ranking of tools

The final ranking of tools according to their overall utilities for BPM can be seen in Figure 2. ARIS is the distinct winner even if only the Design Platform is considered in the analysis. However, the close distance between the commercial references and the OSS tools is a surprise considering their young age. The oldest tool (jBpm) was registered in 2002. Following ARIS, three alternatives are perceived at approximately the same level (jBpm, uEngine, YAWL). Runa follows with some distance. At the last place is AnaXagora.

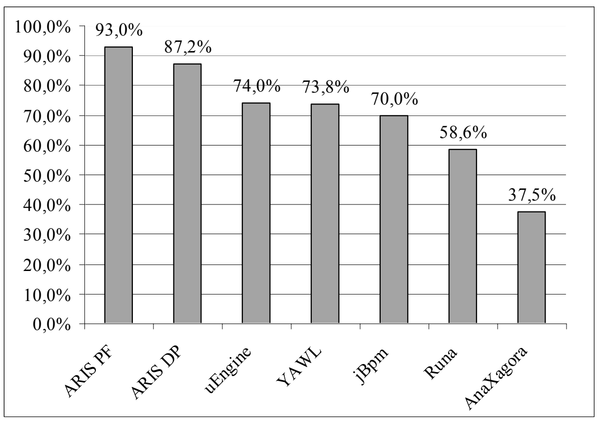

Figure 2. Final BPM utility scores for each BPM tool

Single BPM tool comparisons

The four best GPM OSS tools were placed into net diagrams (as an example see Figure 3) with their commercial reference program to see their main features and development focus in relation to the commercial market leader. A comparison chart shows the percentages of goal achievements of every cluster (see AHP goal hierarchy) for a specific OSS tool and ARIS. The goal achievements consider the weights calculated by AHP. The net diagrams show that the OSS tools each have their own strengths and weaknesses.

uEngine does not comply with many standards due to its own modeling language (no UML, no BPMN, no BPEL, etc). In terms of didactic aspects, the whole spectrum of attributes was assessed on some middle level. Strengths were seen e.g. in terms of the system architecture (single IDE, web access, scalability, etc).

YAWL has its main strength and weaknesses related to its own (proprietary) modeling language, which does not support many standards. The modeling methodology has great expressive power and is effective for process implementation. It supports all identified workflow patterns from scientific research. However, the reporting functions are not effective. There is no substantial support e.g. for model reuse, versions & process development stages, or reference modeling.

Also jBpm can not supply sophisticated performance reporting. We also did not see any controls for syntactic definitions and access rights for the modeling application. In terms of process implementation jBpm is very mature. It also supplies a high level of effectiveness and efficiency through a versioning system, model repository, re-use functions, and other. Its weaknesses can be seen in the area of didactic, e.g. in their help system, access to printing, quality of documentation.

Where jBpm shows weaknesses, RUNA seems to offer strengths. However, this applies also in the other direction, i.e., vice versa: RUNA has weaknesses where jBpm showed strengths apart from process implementation where both systems rely on the same component.

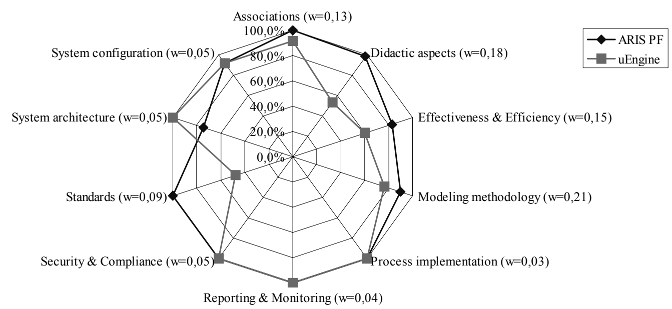

Figure 3. uEngine net diagram

CONCLUSIONS

This paper analyzed OSS projects and a commercial reference based on a methodical combination of the Utility Ranking Method and the Analytic Hierarchy Process. Consequently, it draws on a multiple attributive assessment approach. The attributes were gathered in a bottom-up literature analysis followed by a validation with prior studies.

Considering the age of the assessed OSS projects, their functionality for BPM is already impressive. The OSS tools provide eligible alternatives to ARIS in particular for teaching and demonstrations and for BPM research (e.g. YAWL with its scientific foundation). Each OSS project has its own strengths and weaknesses. However, as for every OSS project no guaranteed continued development of a project can be expected. In this sample we have seen that many combinations and branches of projects are possible and common, e.g. RUNA uses process engine from jBpm.

The user innovations surfaced from the OSS tool analysis show that tools concentrate on model driven business process architectures. In the OSS world, the process and workflow models are seen as unified models. In the commercial world, workflow models are often referred to as an abstraction of the business process models concentrating on steps that can be automated. The latter makes it difficult to implement an end user centric and model driven parameterization of (operational) business processes in enterprises. In terms of expressiveness of the used modeling language, the unified approach seems to work well. Most tools provide their own meta-model, i.e. a proprietary solution for the modeling language. If the OSS community continues to develop their projects according to their user needs in the same pace, we perceive them as eligible alternatives to commercial products even for large enterprises. This work further supports the view at our research institution that OSS tools can already be used effectively in the class room in conjunction or even as alternative to commercial ones.

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