Evaluation of business process management systems

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***Abstract*—Nowadays, more and more industrial organizations are modeling their business processes and implementing business process management systems. Therefore, it is very important to choose a suitable business process management system. The main purpose of this paper is to propose and verify the framework for evaluating business process management systems. This method covers the most important aspects of a business process management systems from the design to the monitoring of the business process. The main advantage of the proposed approach is that it is independent from any specific domain and execution engine. The evaluation framework was tested by applying it to four different business process management systems: "Bonita BPM", "Camunda", "jBPM", "Activiti".**

Keywords—Business process; Business Process modeling; Business Process Management System

I. INTRODUCTION

Bas Steen suggested definition of business process: "A business process is a chain of activities, performed by entities that takes one or more kinds of inputs and creates an output that is of value for one or more entities" [1] is used in this paper. Business process modeling helps organizations to graphically define existing business processes (who, how, what and why does), to identify business problematic areas, to define potential risks and to improve the process while making decisions. It also provides a better and consistent understanding of business processes, improves communication between different interest groups, helps to identify, detect and manage organizational knowledge and provides a possibility to re-use previously modeled and verified processes [2].

Business process management system is a system that completely defines, manages and executes "workflows" [3]. It is hard to choose the right business process management system, because there are no defined criteria for doing that. Without them, choosing the system is subjective, since organizations cannot devote a lot of resources to comprehensively analyze the systems. Therefore, in order to analyze business process management system more efficiently, evaluation criteria have to be defined.

The remainder of this paper is structured as follows: Section II presents the proposed framework for evaluating business process management systems; Section III presents the comparison between open source business process managements systems; Section IV concludes the paper.

II. THE FRAMEWORK FOR EVALUATING BUSINESS PROCESS MANAGEMENT SYSTEMS

Criteria identified during literary analysis were divided into six groups:

- Business process modeling criteria – evaluate systems ability to model clear and complete processes and to import and export them;
- Systems development criteria – evaluate business process execution capabilities and user interface design;
- Installation and performance criteria – evaluate versioning and aspects relevant to the processes execution;
- Monitoring and control criteria – evaluate aspects relevant to monitoring and controlling during the execution of processes;
- Processes and data analysis criteria – evaluate systems capabilities for users to analyze business processes and other relevant data in the simplest possible way;
- Common criteria – evaluate systems information accessible to its users and the use of the system.

The evaluation criteria and the systems has been selected on the basis of what is most relevant to small and medium-sized organizations. Evaluation conditions and weights were defined for each criterion. Weighting (1 to 3) reflects the importance in the whole range of the analysis. To simplify criteria evaluation for the people doing this work, each of the criterion can be assessed in a four-point scale: 0 – the system does not meet the criterion; 1 – the system meets the criterion minimally; 2 – the system meets the criterion at an average; 3 – the system fully meets the criterion. Weights and criteria identification is quite subjective (using analyzed literature and "know-how" principle) in this work, since no way to adapt formal methods was found.

Maximum score is calculated by multiplying weight by maximum possible points (3).

A. Process modeling criteria

Part of the companies have already modeled (not necessarily formally) the current ("as-is") organization model, before the development and/or implementation of the processes

management system. Modeled existing process forms the basis for process improvements, which are then added to the desired ("to-be") process [4]. It is therefore important to know whether it is possible to import already created models into the system.

One of the most important criteria for this group is the modeling of processes, indicating that the system allows to model processes using formal business process modeling language [5]. Currently, there are different languages and standards for business process modeling, such as IDEF, Petri nets, WPDL, UML2, BPMN. Business modeling language comparison is not included in this research work tasks, but other authors examine this topic ([6], [7]). After modeling business process, it is relevant to know process statistics, e.g., to identify how many message flows, roles there are, what the cost are, and to model data [8].

In addition to the modeled active structure (processes) and passive structure (data), it is also important to define business rules [8], [9]. Business rules can be modeled in three different ways [5]:

- all the business rules are modeled into the business process, usually as decision points;
- business rules are managed separately, and links to business rules are given in business process model;
- business processes are not modeled in business process, but are created from business rules.

To re-use process modeled in the system or to give it to someone, ability to export it in various formats is required [8].

The simulation parameters and evaluation conditions are given in Table I.

TABLE I. PROCESS MODELING CRITERIA

Process modeling criteria	**The evaluation conditions**	**Weight**
Process import	If it is possible to import already created processes in XML format, 1 point is given. For every other data import format an additional point is given, but no more than 3 points in total for this criterion.	1
Process modeling	If BPMN is supported, 3 points are given (since it is a standard language). If system does not support it, 1 point is given for each other standard process modeling language, but no more than 3 points in total for this criterion.	3
Data modeling	If there is a data modeling possibility, 1-3 points are given, considering the possibilities and flexibility.	3
Business rules	If there is at least one way to model business rules, 3 points are given. If business rules cannot be described fully, 1 or 2 points are given.	3
Model export	If the model can be exported into a picture, 1 point is given. For each other export option, 1 additional point is given, but no more than 3 points in total for this criterion.	1

B. Systems development criteria

One of the most important criteria in the field of this paper is the translation of modeled business process into executable business process model. This means – the system must support at least one business process execution language and, translation between business process modeling and execution languages. All the systems being compared, must have this functionality, since only the systems which execute business processes are relevant in this paper.

The following two criteria are related to users who interact with business processes. Generally, users use forms (web portals) to send data to business systems, and a tool is required to specify user roles and rights to participate in the process [5], [8], [9].

Business process integration with different systems is also important in systems development (e.g., databases, customer relationship management systems) [5]. Integration is particularly important if the organization uses different systems, because it would facilitate the organization's staff work. Integration with other technologies and frameworks, which can ease and accelerate the development of the system, is also important. A valid aspect of the evaluation of this functionality is supported programming languages [5].

Systems design parameters and evaluation conditions given in Table II.

TABLE II. SYSTEMS DEVELOPMENT CRITERIA

Systems development criteria	**The evaluation conditions**	**Weight**
Process translation into executable business process model	If the process of translation into executable business process model is manual, 1 point is given. If it is done automatically, but requires human interaction, 2 points are given. If the translation is fully automatic, 3 points are given.	3
Creation of user interface (forms)	If only independent of the business process forms can be created, 1 point is given. If forms can be created based on processes diagram, 2 points are given. If forms of designed processes and / or data models can be generated (not necessarily complete), an additional 1 point is given.	3
User management	If there is a possibility to assign roles to the users, 1-3 points are given considering the possibilities (how roles are defined; is there a possibility to assign more than one user to the same role…) and flexibility.	2
Integration with other systems and technologies	If there is a possibility to integrate the system being developed with other systems and technologies, 1-3 points are given considering the possibilities and flexibility.	2

C. Installation and performance criteria

Business processes and other components version management is important to maintain the traceability of processes [5], [8].

Some of the steps of the process cannot be completed without user interaction, therefore, user information is required. User information can be done in two ways [5]:

- active informing – user is informed on what he has to do, i.e. via email;

- passive informing – user can view his activity log, e.g., through the portal.

User interface customization function allows user to change its parameters, like user interface color, time zone, language, etc. [9]

Modeling criteria and evaluation conditions given in Table III.

TABLE III. INSTALLATION AND PERFORMANCE CRITERIA

Installation and performance criteria	**The evaluation conditions**	**Weight**
Versioning	If system has component versioning, 1-3 points are given considering the possibilities (if components that can be versioned are business processes, data models, forms…) and flexibility.	1
User information	If user can be informed via email, 1 point is given. If there is at least one other information method, 1 additional point is given. If use is being passively informed, 1 point is given. All points in this criterion can be summed.	2
User interface customization	For each variable user interface parameter, 1 point is given, but no more than 3 points in total for this criterion.	1

D. Monitoring and control criteria

Real-time monitoring can be helpful in detecting process bottlenecks and identifying emerging risks and interfering in to the process before occurrence of the damage [10]. Reacting to the information visible during process monitoring, users may want to change business processes or stop them [5] [8]. This is usually done in business process execution time when unforeseen conditions or errors occur.

Monitoring and control criteria are given in Table IV.

TABLE IV. MONITORING AND CONTROL CRITERIA

Monitoring and control criteria	**The evaluation conditions**	**Weight**
Business process monitoring	If there are tools that allow to monitor processes in real time, 1-3 points are given considering the possibilities (if it can be done with the system itself or an external tool is required) and flexibility.	2
Business process control	If processes being executed can be modified, 1-3 points are given considering the possibilities and flexibility.	2

E. Process and data analysis criteria

To verify if business processes will be executed as expected, it is convenient to run a business process simulation. For example, when new version of current process is modeled, it can be simulated before releasing into production to choose between the versions [5].

Another important aspect of the analysis is modeled business process verification. Verification is used to verify modeled (being executed) business process validity against the semantics of business process modeling language being used (it can be done, if (executable) business process model was modeled using business process modeling/execution language that has a clear semantics) [5].

Data visualization tools (various diagrams (column, pie and histogram), graphs, scales) are critical when analyzing data [5]. Data visualization gives the ability to identify patterns and find exceptions [11]. Therefore, to analyze data more easily and see strengths and weaknesses, tool that visually represent chosen data/statistics are required.

Process and data analysis criteria and evaluation conditions given in Table V.

TABLE V. PROCESS AND DATA ANALYSIS CRITERIA

Process and data analysis criteria	**The evaluation conditions**	**Weight**
Process simulation	If process simulation is possible, 3 points are given. If an additional tool is required to do a simulation, 2 points are given. If process simulation is limited (for example, not all parameters, like business rules, are considered during simulation), 1 point is given.	2
Modeled process check (verification)	If modeled business process verification is possible, 1-3 points are given considering the possibilities and flexibility.	1
Visual data mapping tools	If there are tools allowing to visually represent data, 1-3 points are given considering the possibilities (can this be done with the system itself or additional tools are required) and flexibility.	2

F. Common criteria

Other aspects, besides business process management systems provided functionality, are also important. It is important not only to choose the right system, but also to learn to use it as quickly as possible and to get the required information: get needed help and access learning material. For users to be able to help to improve the system and report found issues, it is important to have an easy and fast way to send suggestions to the system creators. This functionality helps to create a connection between systems users and creators.

Common criteria and evaluation conditions given in Table VI.

TABLE VI. COMMON CRITERIA

Common criteria	**The evaluation conditions**	**Weight**
Multilingual assistance	For each language in which help is provided, 1 point is given, but no more than 3 points in total for this criterion.	1
Training material	If training material is available, 1-3 points are given considering their abundance, detail and availability.	1
Suggestions for improvement	If user has the possibility to provide systems improvements suggestions, 1-3 points are given considering the possibilities and flexibility.	1

The framework contains only recommendations for assessing business process management systems. The comparison criteria of business process management systems are flexible; therefore, anyone can easily change the weights

according to what is most important for a specific project or product. Moreover, evaluation scale can also be changed: it can be narrowed (to two or three different grades) or expanded (for example, to introduce a ten-point rating scale). Furthermore, more criteria can be identified if required. The order of criteria evaluation is flexible. It is recommended to evaluate each system separately: to better evaluate specific system's function, it is advised to fully evaluate the first system and only then proceed to the next one.

III. Comparison of Business Process Management Systems

Four open source candidates have been chosen according to projects currently being ran in university academic department: "Bonita BPM", "Camunda", "jBPM", "Activiti".

"Bonita BPM" is an open source business process management and business process software collection, created in 2001 [12]. "Bonita BPM" helps to connect all interested parties, processes and information systems into a single easily manageable platform. In many sources ([13], [14], etc.) three main aspects, which "Bonita BPM" combines, are distinguished: process modeling and software creation, process execution engine and end-user interface.

"Camunda" is a lightweight, open-source platform for business process management [15]. This platform includes all phases of the BPM cycle and allows a continuous update of processes. "Camunda" supports core standards of OMG group for business processes management (BPM): BPMN 2.0, CMMM 1.0 and DMN 1.0.

"jBPM" is a flexible business process management (BPM) package, creating a bridge between business analytics and system developers [16]. This package is unique in that it offers process management possibilities for both business participants and system creators, which allows to create and maintain dynamic processes that require a flexibility for complex real-world simulations.

"Activiti" is a lightweight workflow and business process management (BPM) platform for the actors, systems developers and administrators [17]. "Activiti" supports all BPM aspects in the context of business creation. This includes non-technical aspects, such as analysis, simulation and optimization of business processes, as well as the technical aspects of the development of business process support systems.

Comparative analysis is summarized in Table VII. It contains evaluations of all four of the compared systems. Part of the criteria have been tested during this analysis. However, due to the complexity of some criteria (e.g., integrations with other systems), some are evaluated only considering the analyzed literature.

To demonstrate how systems were evaluated, an example is given: evaluation criterion "Process import" has pre-assigned weight of 1, maximum value is 3. "Bonita BPM" has a function to import using XML, *.bpmn, *.ydx and other formats, so this system gets maximum points – 3.

TABLE VII. Comparison of Business Process Management Systems

Comparison criteria	**System name**			
	"Bonita BPM"	**"Camunda"**	**"jBPM"**	**"Activiti"**
Process modeling criteria				
Process import	3	2	1	1
Process modeling	9	9	9	9
Data modeling	9	9	9	9
Business rules	9	9	9	6
Model export	3	2	2	2
Process modeling score (available points - 33)	*33*	*31*	*30*	*27*
System development criteria				
Process translation into executable business process model	9	9	9	9
Creation of user interface (forms)	9	9	9	6
User management	6	6	6	6
Integration with other systems and technologies	6	6	6	6
System development score (available points - 30)	*30*	*30*	*30*	*27*
Installation and performance criteria				
Versioning	3	3	3	3
User information	6	6	4	6
User interface customization	3	3	0	1
Installation and performance score (available points - 12)	*12*	*12*	*7*	*10*
Monitoring and control criteria				
Business process monitoring	4	6	4	4
Business process control	4	6	4	2
Monitoring and control score *(available points - 12)*	*8*	*12*	*8*	*6*
Process and data analysis criteria				
Process simulation	6	6	6	2
Modeled process check (verification)	3	3	3	3
Visual data mapping tools	6	6	6	6
Process and data analysis score (available points - 15)	*15*	*15*	*15*	*11*
Common criteria				
Multilingual assistance	3	2	1	1
Training material	2	3	3	1
Suggestions for improvement	3	3	2	1
Common criteria score (available points - 9)	*8*	*8*	*6*	*3*
Total score	**106**	**108**	**95**	**84**

"Bonita BPM" system allows importing diagrams, which have been exported from "Bonita BPM" "BPMN 2.0", "Microsoft Visio 2010", "ARIS BPM 7.x", "XPDL 1.0" and "jBPM 3.2" tools using either XML or other formats (i.e.: *.bpmn, *.vdx) [18]. "Camunda", "jBPM" and "Activiti" systems can import a BPMN model from XML format [19], [20], [21]. All systems allow to create models in BPMN language and all of them have data models, which allow users, who model business processes and who not always have knowledge of how to use a database, to review, create and edit these data models.

"Bonita BPM" system also allows to define business rules while defining decision points [18], "Camunda" system allows to define business rules using DMN standard [15], "jBPM" – business rules can be defined in few different ways (decision tables, specification of the rules [20]), therefore, these systems received a maximum available (3) points. "Activiti" system allows to create a business rules task, which can execute one or more business rules [21], therefore, this system got a score of 2 points.

The largest business process export possibilities have been found on the "Bonita BPM" system, since process can be exported not only to an image, BPMN 2.0, XLM, BOS format, but also elements to be exported (e.g., data models, configurations, dependencies, organizations) can be chosen [18]. Other three tools can export business process model to (BPMN) XML format. "jBPM" additionally allows to export to JSON format [20]. "Activiti" also allows to export business process to PNG, PDF and other formats, while typing a slash and specifying a format at the end of URL address, for example {url}/{format} [22].

As mentioned earlier, all systems were required to have a business process execution tool, therefore, all of them were evaluated with a maximum score. Compared systems have form modeling tools, which allows to create required user interface forms using WYSIWYG principle. Moreover, they all allow to manage user roles. "Bonita BPM", "Camunda" and "jBPM" at least part of the form can be generated.

On "Bonita BPM" specification page [18] it is described how to integrate other systems into "Bonita BPM" using REST. On this specification, it is stated that REST integration allows to access all BPM objects (e.g., processes, users) and to integrate with "Google" calendar. In "Camunda" user guide [19] integrations with "Spring" framework, "CDI"/"Java EE" and other technologies is described. In the chapter 10 of "jBPM" documentation [20] integration with "REST" is described, while also integrations with other technologies, frameworks are described in chapter 20. In "Bonita BPM" user guide [21] integration with other frameworks and technologies is also described (i.e.: "Spring" integration is described in chapter 5). To evaluate integration realistically and accurately, an experience with the system is required.

All systems under comparison have business process versioning, which ensures that former version can be restored if needed. Since this criterion was evaluated only considering the analyzed literature and versioning was described in all of them, all systems received maximum available score of 3.

"Bonita BPM", "Camunda", "Activiti" documentations state that email send events can be configured while modeling business processes. No other active information possibilities were identified during the analysis. Passive information about tasks to be done, etc. can be seen when logged in to any of the systems.

"Bonita BPM" system allows to define toolbar size (normal or small), choose grid options (e.g., whether to show a grid on new diagram) and to choose whether to suggest to change diagram name when saving the first time (if this is enabled, every time a new diagram is saved, a window is displayed where the name of the diagram can be changed). Moreover, "Bonita BPM" portal allows to apply a profile (e.g., create new menu items) [18]. "Camunda" platform allows to define process appearance (task color and icon can be changed) when creating a new process. The portal allows to create new filters and specify their name, description, color and priority [19]. Information about user interface customization on the "jBPM" platform was not found. "Activiti" allows to customize a palette, which is offered for users while modeling processes [21].

"Bonita BPM" allows to monitor during the execution of processes and see information about them: their list, how many errors occurred, how many cases execute without errors and how many of them are open. User can only monitor processes they control [18]. To monitor processes modeled using "Camuda", an additional system "Camuda "Cockpit" is required [15], which allows to do data filtering and searching, review historic data and do process control actions (cancel processes, edit variables, etc.). "jBPM" also allows a detailed process monitoring – data filtering and searching, "look'n'feel" website tools [20]. In "Activiti" process owners and administrators can review a detailed information of processes being executed [17].

"Bonita BPM" and "Camunda" systems provide a possibility to change processes in real-time. "jBPM" also allows to do minor process changes (e.g., edit variables) [16]. "Activiti" allows to stop processes being executed [21], however, no other control function of process being executed could be found and tested.

All, except "Activiti", systems allow to run a process simulation and review its results. It helps to identify what needs to be changed in the process to achieve the best results. "Activiti" does not have that kind of functionality, however, the user guide describes how it can be done using an experimental tool called "Activiti-Crystalball". All systems documentations (or user guides) state that the system can verify business processes modeled using BPMN notation. Also, each system provides a possibility to visually review certain information, which helps to analyze data and make decisions about process modification.

Information on the "Bonita BPM" website [12] can be found in three languages – English, French and Spanish. "Bonita BPM" website also provides various training and informational material: web-seminars being organized and other events, BPM, process and video libraries. Furthermore, there are other websites dedicated to this tool community and documentation. "Camunda" website [15] provides information

only in English, however some articles can be found in German. Moreover, “Camunda” website offers a user guide, examples, information about standards used in this system and links to forums (consumers and developers). “jBPM” website [16] use only English language. It provides links to training videos, slide shares and documentation, forum. “Activiti” website [17] provides links to user guide and forum and all the information is only in English. Besides, all the systems offer a way to provide a feedback to the developers.

Figure 1 shows a radar diagram business process management systems compared.

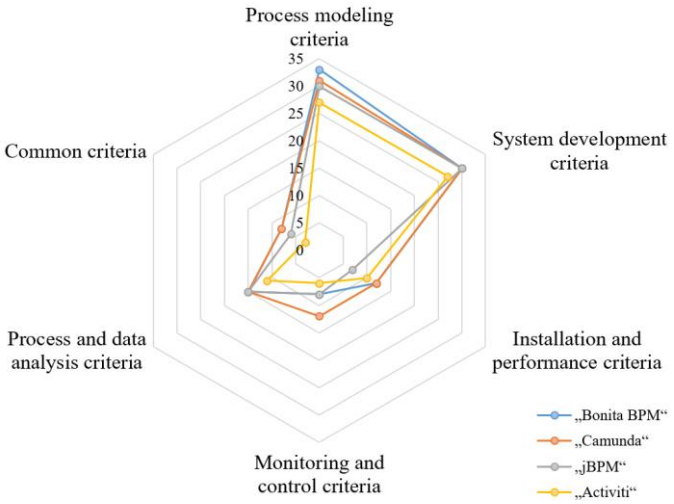

Fig. 1. Radar diagram of business process management systems

After doing a comparative analysis of business process management systems and considering an evaluation table (Table VII) and a radar diagram (Fig. 1) it was identified that the best match for defined criteria is the “Camunda” system.

IV. Conslusion

This paper presented a framework which allows to comprehensively evaluate selected business process management systems. The evaluation framework itself consists of selected criteria and information on how to valuate these criteria. This evaluation framework is flexible, therefore, everyone can adapt it to their needs: choose the most important criteria or add more, change the weights, evaluation scale or change the order of criteria. For demonstration purposes, an example of implementation of the proposed framework on four business process management systems (“Bonita BPM”, “Camunda”, “jBPM“, “Activiti”) has been presented. Finally, the comparison of these systems was made.

This framework will be used in further research of university academic department and in author’s Final Degree Project where this framework will be used in creating information system for specific domain.

References

[1] B. Steen, "Generation of optimal business processesfrom business rules," 2009.

[2] M. Indulska, P. Green, J. C. Recker and M. Rosemann, "Business Process Modeling: Perceived Benefits," in 28th International Conference on Conceptual Modeling, Gramado, 2009 (unpublished).

[3] D. Hollingsworth, "The Workflow Reference Model," 29 11 1994. [Online]. Available: http://www.aiai.ed.ac.uk/project/wfmc/ARCHIVE/DOCS/refmodel/rmv1-16.html#I11. [Accessed 20 02 2017].

[4] M. Rouse, A. Stuart, "Business process modeling," TechTarget, vasaris 2012. [Online]. Available: http://whatis.techtarget.com/definition/business-process-modeling. [Accessed 09 11 2015].

[5] S. R. Koster, "An evaluation method for Business Process Management products," University of Twente, Enschedė, 2009.

[6] B. List, B. Korherr, "An evaluation of conceptual business process modelling languages," in SAC '06 Proceedings of the 2006 ACM symposium on Applied computing, New York, 2006.

[7] H. Mili, G. B. Jaoude, É. Lefebvre, G. Tremblay, A. Petrenko, "Business Process Modeling Languages: Sorting Through the Alphabet Soup," ACM Computing Surveys (CSUR), vol. 43(1), pp. 7-26, 2010.

[8] S. D. Jha, 17 June 2015. [Online]. Available: https://www.linkedin.com/pulse/bpm-tool-evaluation-survey-review-global-community-sunil-dutt-jha. [Accessed 06 11 2015].

[9] M. Scannapieco, "Business Process Management: Basics" [Online]. Available: http://www1.unece.org/stat/platform/download/attachments/108103374/Day%201%20-%20Item%204%20%20-%20Business%20process%20modelling.pdf?version=1&modificationDate=1420617654782&api=v2. [Accessed 11 11 2015].

[10] Pegasystems Inc., 2015. [Online]. Available: http://www.pega.com/business-process-monitoring. [Accessed 9 11 2015].

[11] N. Shamas, "Techcange," 19 May 2015. [Online]. Available: https://www.techchange.org/2015/05/19/data-visualization-analysis-international-development/. [Accessed 14 11 2015].

[12] "Bonitasoft," Bonitasoft, Inc., [Online]. Available: http://www.bonitasoft.com/. [Accessed 15 10 2015].

[13] B. Markmann, "Has open source BPM arrived?," Counterpoint Consulting, Inc., 8 July 2013. [Online]. Available: http://c20g.com/has-open-source-bpm-arrived/. [Accessed 24 10 2015].

[14] "Eclipse marketplace," [Online]. Available: https://marketplace.eclipse.org/content/bonita-bpm. [Accessed 31 10 2015].

[15] "Camunda," 2014. [Online]. Available: https://camunda.org/. [Accessed 14 10 2015].

[16] "jBPM," 2015. [Online]. Available: http://www.jbpm.org/. [Accessed 14 10 2015].

[17] "Activi," [Online]. Available: http://activiti.org/index.html. [Accessed 30 10 2015].

[18] "Bonita BPM documentation website," Bonitasoft, Inc., 2015. [Online]. Available: http://documentation.bonitasoft.com/. [Accessed 10 11 2015].

[19] "docs.camunda.org," [Online]. Available: https://docs.camunda.org/manual/7.3/guides/user-guide/. [Accessed 31 10 2015].

[20] "jBPM Documentation," JBoss jBPM team, [Online]. Available: http://docs.jboss.org/jbpm/v6.3/userguide/. [Accessed 03 11 2015].

[21] Alfresco, 05 11 2015. [Online]. Available: http://activiti.org/userguide. [Accessed 11 11 2015].

[22] "Activiti Modeler: export/print a diagram," Activiti, 26 07 2010. [Online]. Available: https://forums.activiti.org/content/activiti-modeler-exportprint-diagram. [Accessed 06 01 2016].