ENHANCING BUSINESS PROCESS MANAGEMENT WITH KNOWLEDGE

Václav Slavíček

Introduction

Speaking about history of Business Process Management, first we have to glance back, to appreciate the contribution to rationalization and organization of work F.W. Taylor and H. Gantt have made at the beginning of last century. In fact, Process Management has been modernized through past decades alongside with the progression of the whole society. Considering modern history, this applies to process innovations arisen during Industrial Revolution as well as to the onset of Information and Knowledge Society.

The use of process-based management in various organizations was accelerated in 1990s by large number of ERP (Enterprise Resource Planning) implementations together with adoption ofa process-based philosophy. Since that time, process-based techniques have evolved from those being used as just one-off tools applied fora particular purpose towards sophisticated planning, monitoring and control systems which often encompass some quality management strategy [17]. These efforts are collectively called Business Process Oriented Knowledge Management. BPOKM makes it easier for modern organizations to acquire, distribute and utilize business-related knowledge.

The act of passing some work from one participant to another, which has been in the first instance automated bya manufacture, is nowadays driven by Workflow Management Systems (WfMS). Workflow is the automation of a business process, either in whole or just its part, in which documents, information or tasks flow between participants, according to a set of procedural rules [26]. A workflow can involve human participants as well as heterogeneous, autonomous or distributed systems. WfMS facilitates process definition, execution, and monitoring. It not only provides interfaces to access and action work requests. Reporting capabilities and management tools are included as well, so that the workflow can be controlled ona dynamic basis. Evolution of WfMSs has been influenced by related existing platforms and applications: by Groupware Systems, Decision Support Systems, Document Management Systems, Image Processing Systems, to name just a few.

Knowledge Management (KM) as a term exists since 1980s. It can be defined as a systematic and intentional creation, actualization and utilization of knowledge to maximize organizational effectiveness [25]. An individual's knowledge can be processed using several processes including socialization, combination, externalization, and internalization. Knowledge Management can be viewed from various perspectives, namely: Conceptual, Processing, Technological, Organizational, Management and Implementation perspective. Reader should keep in mind that Knowledge Management embraces much more than just an IT infrastructure to support knowledge processes. Organizational culture and interpersonal relationships are of an equal importance [3].

In principle, BPMS can be understood as a superstructure built over WfMS. With Knowledge Management gaining on general importance, know-how and procedural knowledge are perceived as valuable organizational assets. Considering this, Workflow Management Systems set to work on the business process field can be therefore regarded as systems that assist in gaining and subsequent effective utilization of organizational process capital. This obviously requires prior externalization of the knowledge behind processes.

In recent years, numerous enhancements have been proposed to close the gap between business processes and KM. Examples are WfMSs integrating knowledge-related counterparts, building highly adaptive WfMSs, or interlacing design phase and execution phase, to name a few. Nevertheless, there are usually various difficulties on the way of putting these concepts in practice. There

can be several barriers hinderinga deployment of knowledge management in an organization, ranging from limiting the efforts on the IT infrastructure level to natural aversion to innovations. In this paper, we describe the BPOKM problem domain, and present two illustrative examples of projects in which the author of this paper has been personally involved. We also introduce related work, focusing on those concepts which seem to be easily transferable to practice. The rest of the paper is organized as follows. First, the mission of Knowledge Management in Business Process environment is outlined. Second, some critical preconditions are described to accomplish the goals lined out above. These preconditions namely involve ensuring workflow flexibility, integration with other systems, and focusing on human participants. Third, examples of two projects from healthcare and software engineering which deal with the above- described issues are attached. Lastly, the paper concludes witha discussion on possible future trends.

1. Knowledge Management in Business Process Context

T.S. Raghu and A. Vinze pinpoint an importance of Knowledge Management in the interaction between various aspects of business processes [19]. First, there are four key aspects defined which form the knowledge context kernel:

- Workflow Execution.
- Information processing.
- Decision Making determined by the nature of Business Rules (Formal vs. Informal) and Business Procedures (Static vs. Evolving).
- Motivation Structure.

At the same time, there are three phases that account for the continuous evolution of knowledge:

- Knowledge Storage and Retrieval.
- Knowledge Sharing and Distribution.
- Knowledge Synthesis, which leads back to the first phase.

These phases of a particular knowledge process resemble four phases of Knowledge Management formerly described by Wiig: i) Conceptualization Phase to identify, represent, and classify knowledge in relation to organizational processes, ii) Reflection Phase to find out further opportunities for infrastructure improvement, iii) Act Phase during which is the knowledge actually distributed, and finally iv) Review Phase to assess the knowledge infrastructure in operation [24]. Let's take an example from Software Engineering. There can be a knowledge identified thata typical customer only uses specific part(s) ofa SW product. This can lead to an improvement in the helpdesk process.a workflow can assure thata general call froma specific customer is targeted directly by the department with an appropriate specialization. Once the change has been implemented, its real contribution can be compared with the former approach where every call had been first evaluated by the 1st line support.

According to [20], Workflows can be viewed from different perspectives, namely: i) Control-Flow, ii) Data, iii) Resource, and iv) Exception Handling perspective. Comparing these perspectives with the business process aspects quoted above, we can find that the Workflow Execution aspect relates to Control-Flow Perspective, and the Information Processing aspect to Data Perspective, respectively. Decision Making can be mapped either to Data or Resource Perspective, since we can either arbitrate in the process control-flow, or to take a decision upon resources (typically human participants) to put on. Motivation Structure demands attention on the organizational level of Knowledge Management rather than on the technological one, even though subtle hints on the WfMS level can also stimulate the participants towards better cooperation.

2. Challenges

It is obvious from the previous section that the existing literature revolves around similar concepts when trying to tackle issues related to BPM and KM integration. First, both BPM and KM providea set of facets so that these two autonomous domains can be connected together. Second, both these domains have to be handled in a specific way. The following paragraphs enlist topics we have identified as meriting particular attention, together with possible solutions to the presented problems.

2.1 Boosting Workflow flexibility

Some researchers still prefer the concept where process definition is strictly logically separated

from process execution [14]. Given, however, the dynamic and vibrant nature of today's business, organizations have to continuously learn and innovate to remain competitive. This actually speaks for an interleaved or even simultaneous design and execution. In order to effectively support business processes in uncertain and/or error-prone environments, workflow systems must be able to adapt themselves effectively when deviations from the designed process occur during their execution. Such "exceptions" within the Exception Handling workflow perspective can include process enactment errors, violations of the assumptions on resource availability, or even changes in the real processes not yet reflected in the current model [1].

In a nutshell, workflow flexibility can be defined as an ability of the system to react on:

- Incorrect or inaccurate business process model;
- Unexpected or rare situations;
- Adjustment of the process model, usually occurring in relation to a continuous process improvement.

The flexibility should assist both ina redesign of the process model, as well as in an easy change of the control-flow. At each split within the model, the chosen branch is determined bya decision. We can talk about *Flexibility by Selection or Flexibility by Adaptation* if there are several execution paths through the process ready to be selected ona per-instance basis to take account of the prevailing circumstances, or if the model behind processes can be adjusted, respectively [12].

Flexibility by Selection can be improved by advanced techniques involved in Decision Making. Example is Case-based Reasoning or an employment of Soft Computing (fuzzy logic, genetic algorithms, or neural networks). Flexibility by Adaptation (optionally referred to as Workflow Evolution) has been introduced in 1990s [4]. Still being a subject of scientific interest, it is nowadays supported by all major commercial WfMSs.

There is one essential question: To what extent should be WfMS reliant on human intervention on critical junctions? We contend this fairly depends on the type of business. In organization dealing with knowledge-intensive processes like R&D or consultancy, the human aspect in situations requiring ad-hoc decisions is undisputable.

To summarize, the following features should be present in WfMS when targeting flexibility:

- Model Evolution – unlike static workflows, flexible workflows evolve during their execution to a certain extent.
- Stochastic Nature – In contrast to a static workflow where transitions are more or less deterministic, the flow of a process in flexible workflows is less predictable.
- Advanced techniques used in Decision Making.

2.2 Integrating WfMS with Knowledge Management Systems

Knowledge-intensive work is usually based both on formal and informal team communication and cooperation [10]. When developinga BPMS for knowledge-intensive environment, the main challenge is to provide an architecture which facilitates acquisition, sharing and distribution of the worked-out knowledge. Conventional workflow models are considered rigid for this purpose. The following subsections discuss those types of activities which ought to be supported by such a system.

2.2.1 Collaboration

There is no doubt collaboration has gained a widespread importance in past decades, and this trend does not seem to stop. An integration of WfMS with a Collaborative Software (Groupware) can bring us added-value in terms of easier knowledge requisition and classification. Examples are comments, web discussion, or FAQs related to a process instance, created and utilized by several participants during the process lifecycle. In addition, this knowledge can be used again with similar instances in the future.

According to [10], basic requirements to accomplish such a fusion are following:

- Flexible models of organizational structure (people, roles, skills, teams, tasks...).
- Analysis of patterns of interaction between team members.
- Models of general tasks with assigned document templates.
- Establishment of inter-organizational processes and ad-hoc processes witha high degree of abstraction. Inter-company WFMSs in colla-

borative businesses obviously require a prior knowledge transfer among participating organizations [15].
- Integration of database repositories to store knowledge. Again, this means to enrich raw information (i.e. DB records) witha context (e.g. the tasks these data are involved in).

2.2.2 Organizational Learning

Once organizations have acknowledged the potential of Knowledge Management, Organizational Learning is discussed for its potential to enhance decision-making processes. Integration of WfMS with Organizational Memory Information System (OMIS) requires interlaced design and enactment of workflow models. The employed WfMS should support high degree of Flexibility by Selection. The organizational learning begins with the process execution. Its outcome (i.e. terminated workflows with their audit data in the form of cases) is repeatedly stored in OMIS to improve, in turn, the quality and effectiveness of the process model. Besides the technological aspect, the company management must incline towards continuous improvement of business process [23].

2.2.3 Decision Making

To foster a sophisticated decision making, first prerequisite is to extract the decision management from WfMS and put it outside, so that WfMS only focuses on process orchestration and flow design, whereas an outside component provides operational decisions, predictive analysis etc. There are many ways the decision can be performed. Such component can employ Case-Based Reasoning, advanced analytical tools, or enquire an expert's advice to make use of human intuition.

2.2.4 Monitoring Performance

To get the most of the processes having enacted in past, a designated superstructure can be build over WfMS to effectively monitor the performance of business processes within WfMS, and to evaluate their overall performance. The measured parameters can include timelines (i.e. cycle time, delay time), stability, derived cost effectiveness, and utilization [22].

2.3 Considering human aspects of BPM

Deployment of an automated WfMS is often awaiting with high expectations, as the first months of the human-computer cooperation are filled with excitement. However, if the system lacksa possibility of picking up a feedback, the daily routine involving fulfilment of tasks facilitated by WfMS will soon become tedious and repetitive for human participants. Therefore, many people will tend to have their work done as quickly as possible, without actual pondering of the system they use and its possible improvement in a systematic manner. Thus many common escalation issues as well as exceptions will be handled as one-offs instead of their proper codification into the knowledge base.

That is the reason why i) WfMS should enable an interaction and active contribution to achieve its continuous improvement ii) In order to obtain high acceptance of the WfMS, managers should endeavour to keep the people passionate about the process models in use.

3. Illustrative Examples

3.1 Example I: Managing Business Processes in Healthcare

The author of this paper cooperated with an organization running its business in Medical Software Engineering. The organizational goal was to develop a new, innovated version of an information system for hospitals. In this version, the system should be enhanced with an integrated WfMS. The system has been built on Microsoft platform, more specifically on Windows Workflow Foundation (WWF).

There were many requirements imposed on the system. One group of requirements concerned information security. In national health sector, the knowledge storage and retrieval is subject to specific regulatory requirements. One example is the data protection act to protect sensitive information from being abused. Hence access and security issues may limit the knowledge sharing. Besides the security, integrity and availability are also of significant importance. Therefore other important features expected from the system included an audit trail enabling

to trace processes backwards, and implementation of Electronic Signature.

Another requirement was to find the right balance between the depth to which will be information structured on one hand, and simplicity of entering such information on the other hand. Even when keeping bureaucracy to a minimum, there is no doubt some documentation like medical reports and patient case notes has to be supplemented to patient's file for later reference. Majority of medical reports is nothing more than poorly structured descriptive text; therefore it is hard to assure the process and data accuracy. Only features like hypertext can somehow enrich the format and hence structuralize the knowledge being stored.

However, the most challenging requirement was to introduce a support for processes. Outlining a process design for Heath Service proved itself being everything but straightforward. Both in-patient and out-patient care is driven by exact set of rules. Still, higher medical staff including physicians and physiotherapists representsa team of knowledge workers and experts who prefer to act autonomously. To handle the problem, we have decided to use of the following three concepts: Retroactive Workflows, Process Mining, and Facilitator Approach.

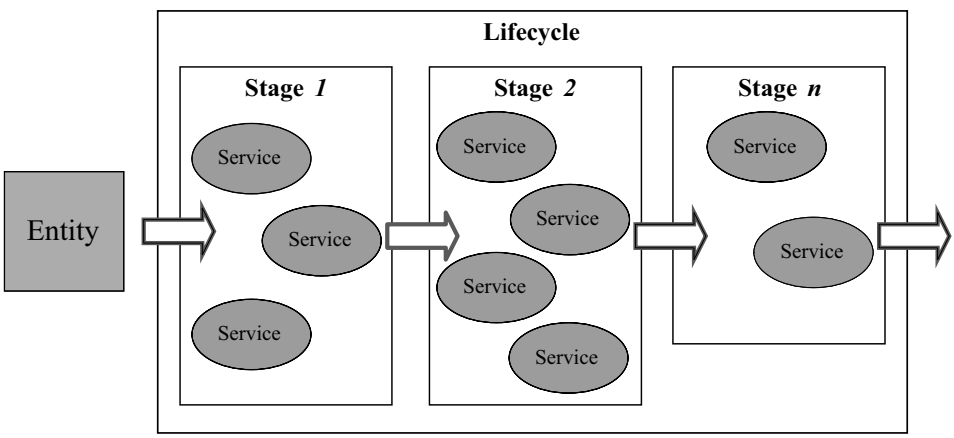
3.1.1 Retroactive Workflows

In the design phase, it proved hard for workflow designers to define any promising workflow model, not speaking about difficulties on the client side to articulate the way people ina medical facility actually work. To map the processes, we needed to track them ex post. We therefore adopted an approach introducing Retroactive Workflows, formerly described in [6], [21]. Conventional workflows can be regarded as proactive, because their design precedes their enactment. On the contrary, Retroactive Workflows require no prior knowledge of the process model. In this case, the model is assembled subsequently by means of a Process Mining tool.

The general process model used by the system is depicted in Fig 1. The entity on the left triggers the specific process. Each process can be described as a sequence of stages. Every stage can be further divided into utilizations of particular services. In this scope, it is however not a predefined sequence what is pushing the entity from one service to another. In general, use of services is not mandatory, and services can be utilized in arbitrary order. Although all stages within the lifecycle must be completed, only some services are compulsive.

In typical example, the entity represents a patient entering the hospital. This triggersa process of patient hospitalization. Data related to the entity are represented by patient's personal details, Admission Report etc. From the control-flow point of view, the process the entity undertakes is divided into several stages. In our example, the lifecycle comprises Admission Stage, Diagnostic Stage, Interpretation Stage, and Acting Stage. Within the Admission Stage, the patient goes

Fig. 1: Business processes as lifecycles, stages and services



Source [6]

through an admission procedure. Here, one service assures that patient's personal data as well as reason of the hospitalization are correctly entered to the system. Another service can provide for hotel services, i.e. bad and food for the expected stay. During Diagnostic Stage, the patient is taken througha set of medical examinations. Within this stage, each service represents a specific examination such as Liver Test, Ultrasound, or PET. These services are usually optional; their utilization depends solely at the discretion ofa human expert (typically a physician). Within the Interpretation Stage, the results of tests obtained during Diagnostic Stage are explained and decisions are made about further actions. Finally, Acting Stage assures that an appropriate action is taken (e.g. a therapy or surgery). Sometimes, specific results delivered by an examination in former Diagnostic Stage may implicate a necessity to take advantage of further examinations. This shows that the sequence of stages should enable iterations.

Similar approach employing Weak Workflows has been formerly described in [11]. Here, the main features were:

- "Lazy" and "Late" modelling; the processes are designed just when they are really needed.
- Interlaced design and execution of processes.
- Gradual hierarchical specification of tasks. Only an abstract model is defined at the beginning, with subsequent top-down refinement.
- Rich set of logic rules to control the process flow.

3.1.2 Process Mining

Summarized information about past healthcare processes is of utmost importance. Once data stored ina warehouse, OLAP analysis can be adopted, for example. Other application areas involve Process Mining as well as benchmark practices. Here, the KPIs are an average time required for providinga service (e.g. to performa medical check), time between ordering and performing medical procedure, average length of stay in the hospital, or time a patient spends in the waiting-room. Not only are the results valuable to the hospital management - they can also serve as an input of scientific research.

Process Mining can be regarded as an implementation of Knowledge Synthesis. The vital requirement is that a sort of process tracking is in operation, so that all control-flow related events are logged in a workflow log. Subsequently, some process mining algorithms like the α-algorithm can acquire the process knowledge, i.e. to discover unknown process models. Another option is to check how existing models conform to the reality. This can evaluate the organizational effectiveness and indicate potential bottle-necks. The post process analysis can reveal what processes really take place in the medical facility. These can quite differ from the original intention of the management. It will indicate systematic rules-breaking in the workplace, as well as reveal novel, creative solutions. We can learn a lot about the real structure of the organization: what departments cooperate with each other, and what communication channels have never been used.

3.1.3 Facilitator Approach

According to [21], business process activities can either directly perform an action (to send an e-mail, for example), or just charge someone else with performing the action on the system's behalf. Based on this difference, activities are either regarded as Automation activities, or Facilitator activities, respectively.

In healthcare, the service delivery is mostly accomplished by humans. Therefore, we had to facilitate tasks to human participants rather than to automate them. Task-lists are present in most of today's Business Process Management Systems. WWF, on the other hand, provides a limited set of out-of-the-box activities, which belong strictly to the Automation category. A typical example is an activity invoking an external web service. That is why we had to design our task-list from scratch. Our task-list is accessible both from the IS user interface, and alternatively through various clients ranging froma web browser to RSS Gadget available on the Windows Vista desktop.

The task-list facilitates common features like delegation of particular tasks to reflect changes in organizational structure (handling of sick-days or holidays). To promote Retroactive Workflows, the task-list was designed so that it also supports the following specifics:

- Tasks can be either grouped to a sequence, or to a set of parallel set. Using these two basic building blocks, a complex hierarchy can be build. Typically,a sequence represents particular stages, whereas the set of parallel tasks represents a cluster of services.

- Within the parallel set, tasks can be prioritized to easily schedule a default order of tasks.
- Although there is a default order, parallel tasks can be still fulfilled in an arbitrary sequence.
- There is an option to skip a task at runtime so that the particular service is never consumed. In the Diagnostic Stage, for example, a task consisting PET scan can be skipped because it is expensive and not always necessary.

3.2 Example II: Managing Business Process in Software Development Industry

Another area where knowledge plays essential part is Software Engineering. This applies to all types of processes throughout the business: analyzing, designing, coding, testing, providing support, or cultivating relationships with customers. Since the traditional face-to-face collaboration is being replaced by geographically dispersed teams, the knowledge is often distributed. The author of this paper has been involved in a team which aim was to improve Business Process Management in a medium-size software development company. Until now, the company was releasing versions of its software products usinga conventional WfMS. a different WfMS assisted in help-desk calls tracking. Separately, a collaborative intranet website has recently been launched to capture all the technical knowledge. Yeta lack of active contributors hampered its further expansion.

In this example, we focus on the following two topics:

- Improvement of a system for Knowledge Sharing.
- Building Semantic web around existing WfMS.

3.2.1 Improvement of Knowledge Sharing

Many software houses have developed their own designated knowledge sharing systems. Majority of such systems utilizes a codification approach. In this approach, a central repository holds the knowledge under categories such as work items, quality control reports, checklists, release notes, and so forth [7]. However, mere deployment of such a system proved insufficient. First, an organization must allow for contribution to knowledge bases and encourage a knowledge--sharing culture by clearly specified incentives [2]. Second, knowledge management systems themselves should assist in a dialogue between individuals rather than just point to repositories.

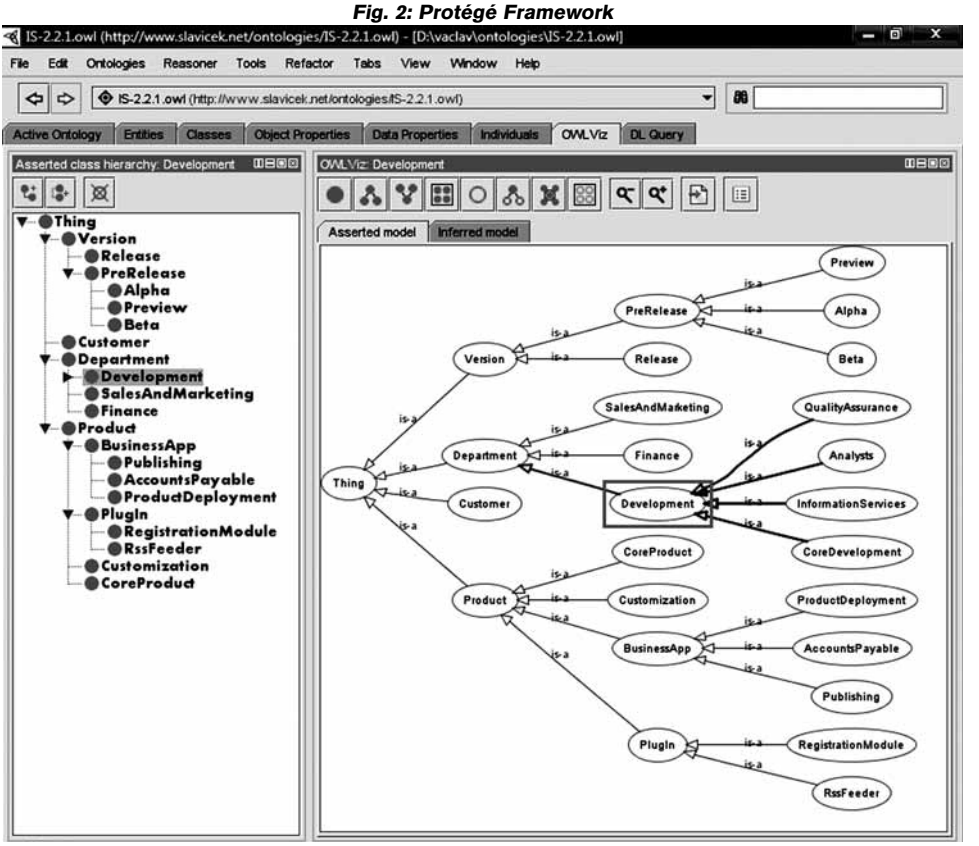
The applied IT infrastructure is not the only aspect that determines the effectiveness of knowledge transfer. We also had to introduce potential stimuli for contributing to the knowledge base. Factors that are likely to affect knowledge sharing include prompting by managers, identification with a group engaged in a common task, and the person's fundamental social orientation (i.e. preposition to sharing) [16]. By making knowledge sharing a pleasurable experience, employees will more incline to take special efforts when coding tacit knowledge into an electronically transmissible format [8].

Success of the knowledge transfer from an individual (i.e. the knowledge source) to others is positively related to his/her domain-related capacity, trust and reputation, and the extent of communication between that individual and the other team members [13]. Similar to the evaluation used in several web communities (examples include eBay or FaceBook), we introduced a feature on the company intranet to benchmark individual's activity in terms of contributing to the knowledge base. Besides the quantity of artifacts added, the quality is measured as well in the following way: Every retrieved piece of knowledge is subject to anonymous evaluation by the particular consumer of the knowledge item. This ensures that even a prospective junior team member can make a valuable contribution to the system with the view of potential reward.

3.2.2 Building Semantic Web

Usually, a software development company consists of project managers, SW architects, consultants, designers, developers, engineers, and so on. In case of software architects, for example, the amount of knowledge lost with such an expert leaving the company is vast. Furthermore, each group named above "live" ina different knowledge context. Hence the source context has to be translated to the context of recipients when transferringa piece of knowledge. This has to be kept in mind whena piece of work (a new software build, for example) makes its way through the organization, passing the phases of consul-

Fig. 2: Protégé Framework



Source: own

tancy, analysis, design, development, packaging, testing, acceptance, eventually ending in hands of sales people. There are various knowledge artifacts attached to the build: Version Number, Development Environment, Required Dependencies, Extra features to be put to the release notes, to namea few.

In a knowledge intensive organization, it is advisable to codify as much knowledge as possible, especially if it is explicit and easy to capture by means of a Semantic Web. Semantic Web is the next generation World Wide Web envisioned by Tim Berners-Lee. Its current technological framework is grounded upon RDF (Resource Description Framework) and OWL (Web Ontology Language). In the context of Semantic Web, data objects of different formats are free to be referenced, thus making both human and automatic processing and reasoning possible [9].

To codify the software-development problem domain, we decided to implement a semantic web using Protégé, and to link it to our WfMS based on Windows Workflow Foundation (WWF) Protégé (see Fig. 2) is a widely used open source ontology editor and knowledge-base framework for knowledge representation and ontology editing [18]. To formally describe ontology the SW development organization, it was necessary to start with a definition of controlled vocabulary. By definition of the unique global view, we could embrace all the complex relationships between particular domain entities. One example relates to Assign Activity, a custom activity which we built in the WWF environment. With this activity, the current assignee can reassign a SW build to a different user, role or team. A sales person can consider a fix included in the SW build as unsatisfactory, for instance, striving to return the

yet-unreleased build back to the development team. Here, the salesman can take an advantage of a context help, revealing the organization structure of the development team, pinpointing who is actually dealing with the specific application. Another example of knowledge retrieved from semantic web is a detailed description of SW dependencies for specific SW build. This is actually possible by virtue of the knowledge query languages such as RQL (RDF Query Language), DQL (DAML Query Language) or SPARQL, which allow to impose queries like "who is the member of development team, dealing with application X".

Besides the integration with WfMS, the semantic web is accessible from the intranet for every knowledge worker within the organization. These employees are often active members in Communities of Interest where they share and exchange ideas and thoughts about the given subject. That is the way knowledge can step over the company internal framework. After all, one can observe the emerging phenomenon of communication, information sharing and interoperability, in internet environment often characterized as Web 2.0 [6]. Examples of such collaboration are instant messaging, collaborative authoring and editing, shared white-boards etc. Once using a shared ontology, the knowledge base can be queried even by other members of the production chain, such as outsourced workforce [5].

Further research should focus on a closer integration of the Semantic Web with WfMS. At present, the web can assist to the human user with a useful hint at the right time. Next challenge is to integrate a knowledge query language with the rules used within if-else activities. As the result, the actual content of the semantic web would affect decisions upon the process flow in an automated way.

Conclusion

To outline possible trends of the future, we expect the described approaches to get more involved in commonly-used tools for BPM. Workflow employed in knowledge-intensive processed will be probably facilitating one, with a limited possibility to influence the way of the execution, within a set of constrains determined by access & security policies. Semantic information extracted from semantic web can serve as a useful hint when participating on particular business process. This information can include records about similar cases which have been solved in past (as a base for Case-Based Reasoning, for example), and annotations as a part of knowledge sharing. These can be in turn mutually evaluated by other team members. This knowledge can be either stored by humans, or by computers. The latter option includes information on performance of completed business processes, or outputs from process mining.

Bibliography

[1] BERNSTEIN, A.; DELLAROCAS, C.; KLEIN, M. Towards adaptive workflow systems: CSCW-98 workshop report. *ACM SIGGROUP Bulletin.* 1999, Vol. 20, Iss. 2, pp. 54-56.

[2] BUREŠ, V. Cultural Barriers in Knowledge Sharing. *E+M Economics and Management.* 2003, Vol. 6, special issue, pp. 57-62. ISSN 1212-3609.

[3] BUREŠ, V. *Znalostní management a proces jeho zavádění.* Praha: Grada, 2007. ISBN 978-80-247-1978-8.

[4] CASATI, F. et al. Workflow evolution. *Data & Knowledge Engineering.* 1998, Vol. 24, Iss. 3, pp. 211-238. ISSN 0169-023X.

[5] CHEN, H.; WU, Z.; XU, J. KB-Grid: Enabling Knowledge Sharing on the Semantic Web. *Proceedings of the 1st International Workshop on Challenges of Large Applications in Distributed Environments,* Washington: IEEE Computer Society, 2003. p. 70. ISBN 0-7695-1984-9.

[6] COVVEY, D. et al. The Representation of Dynamic, Context-Informed Workflow. *BPM and Workflow Handbook: Spotlight on Human Centric BPM.* Lighthouse Point, Florida: Future Strategies, 2008. ISBN 978-0-9777527-6-8.

[7] DESOUZA, K.C. Barriers to effective use of Knowledge Management Systems in Software Engineering. *Communications of the ACM.* 2003, Vol. 46, Iss. 1, pp. 99-101. ISSN 0001-0782.

[8] DESOUZA, K.C. Facilitating Tacit Knowledge Exchange. *Communications of the ACM.* 2003, Vol. 46, Iss. 6, pp. 85-88. ISSN 0001-0782.

[9] DONG, X.; WILD, D. An Automatic Drug Discovery Workflow Generation Tool using Semantic using Semantic Web Technologies. *Proceedings of the 2008 Fourth IEEE International Conference on eScience*, Washington: IEEE Computer Society, 2008. pp. 652-657, ISBN 978-0-7695-3535-7.

[10] DUSTDAR, S. Reconciling Knowledge Management and Workflow Management Systems: The Activity-Based Knowledge Management Approach. J.UCS: *The journal of universal computer science*. 2005. Vol. 11, Iss. 1, pp. 589-604. ISSN 0948-695X.

[11] ELST, L. et al. Weakly-structured Workflows for Knowledge-intensive Tasks: An Experimental Evaluation. *Proceedings of the Twelfth International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises*, . Washington: IEEE Computer Society, 2003. p. 340, ISBN 0-7695-1963-6.

[12] HALLIDAY, J. J.; SHRIVASTAVA, S. K., WHEATER, S. *Flexible Workflow Management in the OPENflow system* [online]. Newcastle: Department of Computing Science, Newcastle University, 2001. [cit 2009-12-15]. Available at: <http://www.cs.ncl.ac.uk/research/pubs/inproceedings/papers/582.pdf>.

[13] JOSHI, K. D.; SARKER, S. Knowledge Transfer Among Face-to-Face Information Systems Development Team Members: Examining the Role of Knowledge, Source, and Relational Context. *Proceedings of the 37th Annual Hawaii International Conference on System Sciences* (HICSS'04), Washington: IEEE Computer Society, 2004. track 8, Vol. 8, p. 80248.1. ISBN 0-7695-2056-1.

[14] KIEPUSZEWSKI, B. *Expressiveness and Suitability of Languages for Control Flow Modeling in Workflows.* Ph.D. Thesis [online]. Brisbane, Australia: Queensland University of Technology, 2003. [cit. 2009-12-15]. Available at: <http://www.workflowpatterns.com/documentation/documents/phd_bartek.pdf>.

[15] LIN, D.; ISHIDA, T. Interorganizational Workflow Collaboration Based on Local Process Views. *Proceedings of the 2008 IEEE Asia-Pacific Services Computing Conference*,- Washington: IEEE Computer Society, 2008. pp. 789-794. ISBN 978-0-7695-3473-2.

[16] MARKS, P. et al. Sharing Knowledge. *Communications of the ACM: Alternate reality gaming,* 2008, Vol. 51, Iss. 2, pp. 60-65. ISSN 0001-0782.

[17] MAY, M. *Business Process Management: Integration in a Web-enabled Environment.* New York: Pearson Education , 2003. ISBN 0-273-66108-6.

[18] *Protégé* [online]. Stanford University, Stanford Center for Biomedical Informatics Research, 2009. [cit. 2009-12-15] Available at: <http://protege.stanford.edu/>.

[19] RAGHU, T.S.; VINZE, A. A business process context for Knowledge Management. *Decision Support Systems.* 2007, Vol. 43, Iss. 3, pp. 1062-1079. ISSN 0167-9236.

[20] RUSSELL, N. *Foundations of Process-Aware Information Systems.* Ph.D. Thesis [online]. Brisbane, Australia: Queensland University of Technology, 2007. [cit. 2009-12-15]. Available at: <http://www.yawlfoundation.org/documents/RussellThesisFinal.pdf>.

[21] SWENSON, K. *Thoughts on Collaborative Planning: Human "Facilitator" Processes* [online]. 2007. [cit. 2009-12-15]. Available at: <http://kswenson.wordpress.com/2007/09/28/human-facilitator-processes/>.

[22] THOMAS, M., et al. A semantic approach to monitor business process performance. *Communications of the ACM: The semantic e-business vision,* 2005, Vol. 48, Iss. 12, pp. 55-59. ISSN 0001-0782.

[23] WARGITSCH, C.; WEWERS, T.; THEISINGER, F. An Organizational-Memory-Based Approach for an Evolutionary Workflow Management System. P*roceedings of the Thirty-First Annual Hawaii International Conference on System Sciences,* Washington: IEEE Computer Society, 1998. Vol. 1, pp. 174. ISSN 1060-3425, 0-8186-8233-7.

[24] WIELINGA, B.; SANDBERG, J.; SCHREIBER, G. Methods and Techniques for Knowledge Management: What has Knowledge Engineering to Offer. *Expert Systems with Applications*. 1997, Vol. 13, Iss. 1, pp. 73-84. ISSN 0957-4174.

[25] WIIG, K. M. Knowledge Management: An Introduction and Perspective. *Journal of*

Knowledge Management. 1997, Vol. 1, Iss. 1, pp. 6-14. ISSN 1367-3270.

[26] *Workflow Management Coalition Specification: Terminology & Glossary* [online]. doc. no. WFMC-TC-1011, ver. 3, issued 1999-05-02. [cit. 2009-12-15]. Available at: <http://www.wfmc.org/standards/docs/TC-1011_term_glossary_v3.pdf>.

Ing. Václav Slavíček
University of Hradec Kralové
Faculty of Informatics and Management
Rokitanského 62, 500 03 Hradec Kralové
vaclav.slavicek@uhk.cz

Doručeno redakci: 10. 8. 2009
Recenzováno: 7. 9. 2009, 8. 10. 2009
Schváleno k publikování: 18. 1. 2011

ABSTRACT

ENHANCING BUSINESS PROCESS MANAGEMENT WITH KNOWLEDGE

Václav Slavíček

Both Business Process Management and Knowledge Management are fully developed, autonomous disciplines. However, for an organization to utilize them to a maximum, these two have to be introduced in a coordinated way. This is a subject of Business Process Oriented Knowledge Management. On the technical level, we can talk about integration of Workflow Management Systems with various Knowledge Management Systems. We have synthesized a number of common concepts described in extant literature dealing with the subject. The challenge lays in their further development and an appropriate application. The paper explains some key terms, reviews related work and identifies common aspects. Next, we define outstanding issues within the problem domain and suggest possible solutions. In particular, we operate with flexibility of workflow models, facilitating collaboration, organizational learning, advanced decision making, and process monitoring. Another topic introduces human aspects of BPM. To further illustrate the outlined theses, two illustrative examples have been attached, namely from national health sector and software engineering industry. For BPM in healthcare, tasks are typically facilitated rather than automated. We propose an employment of retroactive workflows together with process mining. Regarding the second example, software development is a highly knowledge-intensive domain. Hence we focus on a stimulation of knowledge sharing and on capturing knowledge using a semantic web.

Key Words: *Business Process Management, Knowledge Management, Business Process Oriented Knowledge Management, Workflows.*

JEL Classifications: *L22, M15, D83, O31.*