Blending BPMS with Social Software for Knowledge-Intense Work: Research Issues

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Abstract. Knowledge-intense processes are by their very nature exploratory, non-repetitive in detail and not completely known in advance. Flexibility, effective knowledge management and efficient collaboration are important requirements of such processes. A typical flow-oriented BPMS, relying on the generation of a model a priori and imposing a specific sequence of tasks to process participants is not appropriate for such processes, as it does not align with their nature and cannot satisfy their requirements. Therefore, alternative approaches are explored by the research community. An emerging trend towards this direction is the incorporation of social software features in BPMS. However, bringing the BPMS and social software together is not a straightforward task in the context of knowledge-intense work. Several crucial issues arise that should be closely investigated for an appropriate approach to be developed ensuring an efficient execution of knowledge-intense processes. In this paper, a number of such issues are identified helping towards the detection of an effective and efficient solution when blending features from both software types.

Keywords: knowledge-intense business processes, BPMS, social software.

1 Introduction

The flow-oriented paradigm constitutes the dominant business process modeling approach adopted by the majority of current BPMS (Business Process Management System) [1] products. According to this paradigm, business process tasks are orchestrated in a specific sequence using a modeling language such as BPMN (Business Process Modeling Notation) [2], which is subsequently interpreted and enacted by the process engine being part of the BPMS. While typical flow-oriented approaches effectively support the needs of well-structured processes, i.e. processes with well-defined steps, they fall short however to satisfy flexibility requirements addressed in ill-defined processes [3]. The former rely on the generation of a model a priori, which is then enacted multiple times. This logic aligns with their standardized

repetitive type of work. In contrast to that, ill-defined processes are by their very nature exploratory, non-repetitive in detail and not completely known in advance. The main concern in the latter is communication and knowledge-sharing among participants, rather than the coordination of activities [4]. Thus, they are often referred to as collaborative or knowledge-intense processes [5]. A process is regarded knowledge-intense if its value can only be created through the fulfillment of knowledge requirements of process participants. Flexibility is an inherent requirement of such processes [6], as the workflow during enactment is mainly determined by decisions made, often on the fly, by knowledgeable actors, and hence cannot be prescribed by a BPMS. In particular, *flexibility*, *efficient collaboration* and *effective knowledge management* are key requirements for knowledge-intense processes ([7], [8], [9]) that cannot be effectively served by classical BPMSs.

In order to meet the requirements of knowledge-intense processes, researchers are investigating and developing alternative approaches, such as KMDL [10] and CommonKADS [11], focusing on representation, modeling and analysis of knowledge-intense processes and POKM [12], which is a method for capturing the expert's knowledge in such processes. Initiatives focusing on the efficient execution of knowledge-intense processes include efforts such as KnowMore [13], FRODO [14] and PROMOTE [15]. KnowMore augments knowledge-intense tasks of a business process with recommendations and decision support information. FRODO addresses the issue of flexibility, adopting weakly structured workflows, to enable interleaved modeling and execution of knowledge-intense processes. PROMOTE extends the more general method of typical Business Process Management (BPM) with strategic decision, knowledge process discovery, organizational memory creation and enterprise knowledge evaluation.

While constituting important contributions to the field of knowledge-intense process support, none of these initiatives emphasizes the aspects of efficient collaboration between participants through various means as well as the externalization of participants' tacit knowledge [16], which the knowledge residing in peoples' heads. This explains the growing interest towards the emerging trend reflected upon the established term *Social BPM* [17]. The purpose of social BPM is the adoption of social software features in the BPM (Business Process Management) discipline in order to foster flexibility, knowledge management and inter-participant collaboration in business process support. Such merits are of paramount importance in today's highly dynamic market environments, which drive work in modern enterprises to increasingly become more and more knowledge-intense, addressed for example by initiatives such as Enterprise 2.0 ([18], [19]).

Social software is rapidly gaining acceptance as revealed by a new generation that is accustomed to use platforms such as Facebook (www.facebook.com) for communication and socialization purposes. This new way of communication is quickly spreading to the business life as well through the evolution of informal business networks such as LinkedIn (www.linkedin.com). Utilizing social characteristics in BPM could prove worthwhile for several reasons, especially for knowledge-intense processes, since they could effectively serve their key requirements as discussed in the following:

- Communication and collaboration are key features, effectively supported by social software ([20], [21]). Such functionalities are of great significance for knowledge-intense processes, which rely more on participant collaboration rather than an engine enforcing the steps that should be followed.
- Social software can connect actors easier to the resources they actually need [22]. More specifically, they have the ability to find, learn about and connect with the right people, information and other resources to deal with unanticipated situations, thus promoting process flexibility.
- Social software facilitates knowledge updating as it allows for tacit knowledge to be easily externalized and shared in a way that new knowledge is created, by enabling users to reach out to a large number of relevant participants and engage in discussions, and by capturing and making searchable such informal discussions [21].

As the beneficial influence of social characteristics in BPM has already been discerned by the research community, there are already research initiatives towards this direction [23]. However, bringing the BPMS and social software together is not a straightforward task when supporting knowledge-intense work. Important issues arise that should be closely investigated for an appropriate approach to be developed that can effectively satisfy the aforementioned requirements of knowledge-intense processes.

The purpose of this paper is to address research issues emerging from infusing social software features in a BPMS environment, targeting the efficient execution of knowledge-intense processes. To identify such issues, we were grounded on the business process modeling perspectives proposed by Curtis et al [24]. Issues regarding the infusion of social software in BPMS are then discussed from each perspective. Specifically, the paper is organized as follows. Section 2 presents the state of the art regarding the adoption of social features in BPM. Research issues are examined from each perspective in section 3. Conclusions are given in section 4.

2   State of the Art Regarding the Adoption of Social Features in BPM

Business Process Management utilizing social networking concepts has recently gained momentum, due to social software characteristics like weak ties and mutual service provision, which fulfill requirements of collaborative environments ([23], [25]). Moreover, research community's intense interest is reflected upon related conferences and workshops that identify emerging issues, such as the International Workshop Series on Business Process Management and Social Software (http://www.bpms2.org/).

Literature is rich in contributions concerning the adoption of social software features in the BPM discipline. A part of this research focuses on how social software can be used to support collaborative business process design ([26], [27], [28]). Koschmider et al., for example, suggest in [28] an approach, according to which process models can be shared and exchanged based on the network proximity of modelers. Other approaches focus on using social tagging mechanisms for relating

models dynamically [29] or managing them in a model repository [30]. Brambilla et al. [31] have proposed a notation for social BPM defined as a BPMN 2.0 extension. It enables the annotation of specific tasks as collaborative ones and their potential execution within a social network environment. In [32] a BPM infrastructure bearing social software features is proposed, targeting both collaborative modeling as well as business process execution in a fashion that mashes up definition and operation of business processes. The corresponding tool, called AGILIPO, is currently under development and testing. In [33] the authors examine how the architectural principles behind BPMS and social software can be combined in order to develop a unified infrastructure supporting features of both software types. Johannesson et al. [34] suggest a set of guidelines for augmenting BPMS with social software features, which may be effective for knowledge-intense process modeling, though the execution model is not clearly defined. Based on the aforementioned efforts it becomes evident that knowledge-intense process execution will benefit from the integration of social software features in BPMS environments. Thus, we explore a taxonomy of the issues to be solved towards the development of such environments, facilitating the effective execution of knowledge-intense processes.

In practice, though the phenomenon of social networking within an organization gains momentum, as investigated by Richter and Riemer in [35], its usage is restricted in communication and information sharing. That is, the social software infrastructure is used only for exchanging information or performing trivial tasks, such as arranging a meeting, and not for integrated BPM solutions, which seems to be the step forward.

3   Issues Emerging from the Infusion of Social Software Features in BPMS

To identify challenges posed by the infusion of social software features into BPMS, attributes of both software types should be comprehensively explored. To this end, the business process modeling perspectives proposed by Curtis et al. [24] for executable business process description can be applied. According to Curtis et al. [24], a business process model can be viewed from a functional, behavioral, organizational and informational perspective. The functional perspective depicts what activities are performed. When and how activities are performed constitutes the behavioral perspective, while where and by whom they are executed corresponds to the organizational perspective. What information entities are created and processed during each activity is examined in the informational perspective.

Table 1 juxtaposes characteristics of these two software types distinguished in the aforementioned perspectives. As BPMS and social software have a different orientation, they reasonably bear different features, which can even be regarded to a large extent contradictory, as shown in Table 1. Taking into account the diverse features of social software and BPMS, the main problem arising is how BPMS and social software could be merged to efficiently support the execution of knowledge-intense business processes. This question will be further elaborated in the following by examining each perspective separately, having in mind the specific characteristics of each software type .

Table 1. Juxtaposing features of social and BPM software from four business process modeling perspectives

Business Process Modeling Perspectives	Social Software	BPMS

Functional Perspective	- social-specific activities
	   - profile management
	   - networking
	   - communication
	   - context creation
	   - searching
		- business-specific activities (tasks)

Behavioural Perspective	- wisdom of the crowds - social interaction - social production	- wisdom of the expert - prescribed task execution - predefined input from each participant
Organizational Perspective	- egalitarianism - weak ties - public access	- role hierarchy - strong ties - access policies specified by top management
Informational Perspective	- content or context information concerning artifacts or physical objects	- business or physical objects

Functional Perspective

Functionality of a business process is described through business-specific activities often called tasks [2], although a hierarchical relationship may also be defined between these two terms. A business activity can be anything performed within the context of a specific business process. However there are strict descriptions of their input and output as well as the roles/participants responsible for their execution, which constitute parts of their definition. Activities supported in social software, on the other hand, have a more narrowed scope. Thus, we group them in five main categories, namely, profile management, networking, communication, searching and context creation. The first category comprises activities such as profile creation, update, view, etc., while networking involves creating and/or participating in social links or groups. The third category involves message exchange, announcement posting and forum initiation and participation. Searching activities for extracting a wide variety of information (people, places, photos, jobs, etc.) are also provided by

social software. Lastly, another important type of activities offered by such software are those concerning the creation of context, i.e. metadata for the existing data. This can be accomplished through tagging (i.e. using keywords to classify data), evaluating (e.g. through rating or endorsing) and annotating. It should be noted that any participant of a social network or wiki may perform any activity without restrictions.

Would there be any benefit for knowledge-intense processes in case BPMS specifically supported such activities and provided the means for their explicit description, as suggested in [31]? Adopting the idea of creating a profile for each employee within the organization might help, along with corresponding searching and annotation capabilities, towards identifying the appropriate person, in terms of knowledge and experience, for the solution of a problem or the execution of a task in general. In addition, as time in the execution of an organizational process is crucial, the BPMS should also be able to detect the availability of each participant and make suggestions based on participant's current workload as indicated by Bessai and Nurcan [52]. However, their involvement could not be considered only on a voluntary basis, following the social computing model. What kind of information should be included in employees' profiles within the context of an organization to serve the needs of process execution is an issue requiring further research. Information indicating the employees' position, role and responsibilities within the limits of a specific organization should also be included, since they are related to the potential execution of specific tasks, according to predefined business rules.

Apparently, networking and communication activities, a key feature of social computing, may enhance collaboration between participants and help them in knowledge sharing. To this end, it may be useful to augment BPMS with capabilities such as announcement posting and forum initiation as well as creation and participation in social groups. For example, a participant may invite friends, colleges or intermediates – e.g. participants belonging to a specific group - to help him/her to complete a specific task [36]. However, how exactly such features could contribute to the efficiency in the execution of knowledge-intense processes and under which conditions, should be more concretely examined.

Lastly, the concept of context creation could also be adopted in BPM software. According to Erol et al. [4], for example, attaching personal user-oriented description of resources to tasks could create an analogy between tasks and tags in folksonomies. Task-folksonomies, as referred in [4], could be considered an informal way of representing process knowledge, as opposed to the formal representation used in conventional business process models. It is worth investigating how task-related folksonomies, created by participants themselves, could be used to enable automatic detection of resources (data, people, etc.) required for the execution of specific task. Furthermore, the way a specific participant or group of participants may combine tasks to complete a specific goal could be considered as context creation and utilized by other participant with similar goals. Overall, the entire concept of activity/task modeling in a combined social and BPMS environment may need to be reconsidered.

Behavioral Perspective
Two fundamental features of social software are social interaction and social production. The first concerns the communication between individuals without predefined rules (e.g. Facebook), while the second is about the creation of artifacts by

combining the input from independent contributors without a-priori specification of the way doing this (e.g. Wikipedia). In contrast, using a typical BPMS, the interactions among participants are prescribed through rigid process models, specifying the order of tasks as well as the exact way each participant is involved, so that a certain business goal is reached. This mode of work might not suit knowledge workers, as they need support for creative problem solving rather than constraints set by a software system. Could the incorporation of social features in BPM software offer a way of working suitable for knowledgeable actors operating within a specific business environment? What would then be the meaning of social interaction and social production in such an environment? Knowledgeable actors may work together to reach a specific goal in a similar fashion as individual contributors combine input in Wikipedia. Should their interaction be free from any constrained or rule? In other words, the way social interaction and social production notions should be interpreted in an organizational context needs to be explored.

Even when a participant is not knowledgeable in the sense that he/she does not make decisions but mainly performs procedural tasks, he/she might prefer not to work according to the strict workflow-oriented fashion imposed by a conventional BPMS. If workers do not follow a prescriptive model and are let to perform individual processes, they might express new ideas and make suggestions for process improvement, getting thus actively involved in the development of new business process patterns. Furthermore, "collective intelligence" [4] of many people may lead more effectively to the solution of a problem than the knowledge of an expert who is sometimes difficult to be identified. This adheres to the "wisdom of the crowds" idea introduced in [37]. However, one could argue that enforcing participants to follow strict business process models, offers a "safer" way to execute a process with regard to a business goal as in this way it is ensured that participants know exactly what to do and when to do it and that they will definitely contribute in the completion of a process. Indeed, proactive contribution cannot be taken for granted. Participants may not contribute if they are not obliged to. Thus, the issue that arises is how to combine social software features, promoting creativity and innovation, with BPMS support features that accommodate the required control over the executed processes, so that advantages from both sides can be exploited. Also, it should be stressed that for BPM to reap the fruits of social software, it should be ensured that participants are motivated for a proactive contribution [25]. Identifying such motivation mechanisms constitutes therefore another research matter.

If the combination of social with BPM software introduces a novel way of working in a business environment, what kind of process modeling approaches would be appropriate for describing such a way of working? In other words, what does the introduction of social technology into BPMS entail for business process design? Typical flow-oriented models as those described using for example BPMN [2] seem totally inappropriate. Could then message-oriented approaches, such as S-BPM [38], or perhaps an adapted version of them be more suitable? Or would it be better to adopt a goal-driven approach [39]? Or could hybrid approaches amalgamating diverse modeling paradigms be more promising?

Taking into account the current logic underlying social software, the definition of a complete process model prior to enactment would probably not make sense. The effective support of knowledge-based processes underlies an ill-structured model.

One could research whether there would be any meaning in specifying a kind of model to be followed during enactment or perhaps a model would not need to exist at all at the initial execution of a process [36]. Rather, it could be extrapolated automatically [40] through process mining techniques [41] based on worker's actions. In this respect, it might me more useful to model on a more fine-grained level, considering process constituents, i.e. tasks, as autonomous entities [42] and specifying for each task the associated resources and the respective roles allowed to execute it. The extracted process models can be subsequently analyzed and optimized. Through such an analysis stakeholders may gain insight into their everyday work and identify best practices. The identified process patterns could be made available for being shared among participants. These patterns may be continually updated based on the experience and knowledge of workers. Should such business process patterns be used together with a recommendation mechanism or would it be mandatory to follow a specific pattern for the realization of a specific business goal? Behind this dilemma, lies again the issue of ideally combining the freedom and proactive operation of participants offered by social software with conformance to business policies and rules ensured by BPMS. Ultimately, what would be the role of a workflow engine in such type of hybrid software? Would it be required or valid at all? Or could alternative technologies, such as shared spaces [43] turn out more appropriate? Lastly, can we stick to the typical business process lifecycle paradigm as we currently know it or do we need to reconsider it?

Organizational Perspective

Weak ties are formulated through social networks, as opposed to strong ties which are developed through relationships based on hierarchy and team structure. As indicated in [25], weak ties are spontaneously established contacts invoked not by management but by individuals. Egalitarianism [25] is about giving all participants the same rights to contribute, in contrast to organizational environments, where well-defined roles and role interrelationships determine responsibilities within the context of the organization, which in turn are depicted within BMPS environment. Access to information is also determined by roles and policies specified by top management, while social software environments allow for a wider access to information.

In any case, the responsibilities of each employee are determined by his/her position in the organization, accommodated by predefined responsibilities, according to well-established policies. Even in knowledge-intense processes, which should be executed within the context of an organization, where there are not prescribed steps to be followed, knowledgeable participants should adhere to business rules prescribing an organization's policies.

The way relationships are cultivated among business process participants through a social network, according to the aforementioned social software attributes, better facilitate and encourage the exchange of views and ideas [25]. As a result, externalization of tacit knowledge as well as sharing and dissemination of knowledge, which are key requirements for knowledge-intense processes, are better served through social software. However, in an organizational environment not anybody can do anything at anytime. For a harmonious operation of the enterprise, participants should comply with the policies and business rules holding within the enterprise. As a result, the appropriate balance between the freedom offered by social software

facilitating collaboration and knowledge diffusion on one hand, and organizational-specific policies reflected upon business process models and effectively supported by BPMS on the other hand, should be investigated. Such a balance should provide for maximum flexibility, ensuring at the same time that chaos is prevented. This entails that enterprise may need to change the established rules and policies towards Enterprise 2.0 concepts [18].

It should be stressed that the concept of role is key in organizational environments and therefore constitutes a fundamental entity in business process modeling [44]. Since such concept is missing in social software in terms of functional entities, the latter cannot adequately support organizational requirements in terms of business process execution. In a BPMS environment, the concept of "role" is used to denote a set of responsibilities within an enterprise that can be assigned to a specific actor category (e.g. a doctor). The integration of BPMS with social software might prompt for a reconsideration of role description. For example, as stated in [45], the concept of role should be assigned richer semantics to accommodate human interactions in knowledge-intense processes. This might mean to describe for each role the required knowledge and skills to obtain it. On the other hand, there are efforts, identifying the need to introduce the concept of the role, with loose semantics, in private social networks built to accommodate collaborative communities within the context of an organization [46].

To conclude, as also stated by Harrison-Broninski [45], better techniques are required for modeling relationships, both on a personal basis as users and within a process context as roles, in order to support human behaviors such as learning, adaptation and conflict resolution, and typical process features like goals, responsibilities and delegation of authority, which might serve to effectively perform knowledge-intense processes.

Informational Perspective

Information in social software regards objects like photos, songs, e-books etc. associated with metadata developed by participants using tagging, evaluating and annotating (see above). Utilizing the "wisdom of the crowds", participants may also classify information formulating folksonomies, which may help others to seek the information they needed. Thus, context information is available for the content created by participants. In contrast, information in BPMS is depicted onto business objects such as order forms, receipts, invoices, etc., which are strictly related to activities as input or output data. Metadata are critical for knowledge-intense processes, as they correspond to an essential part of knowledge. Embodying therefore metadata to characterize the raw data and exploring how creation and sharing of metadata can be supported in BPMS, is of paramount importance for the promotion of knowledge elicitation.

Currently, modeling of such metadata is not supported in existing business process modeling languages. However, there are several research initiatives towards "context modeling" as it is called [47], falling into various scientific fields such as mobile computing, knowledge management, etc. Regarding the BPM field, there are also related research efforts aiming at capturing through context data the situation under which specific activities are performed, so that contingencies can be effectively handled ([48], [49]). Metadata or context modeling remains an open issue.

Table 2. Issues arising from the combination of BPMS with social software for supporting knowledge-intense processes

Business Process Modeling Perspectives	Issues
Functional Perspective	- Would it be beneficiary for the execution of knowledge-intense processes to create and maintain a profile for each employee? If yes, what kind of information should be included in such a profile? Who would be responsible for updating it? - How could networking and communication activities contribute to the efficient execution of knowledge-intense processes? - How could context created by participants may be used by others to enable automatic detection of the resources required for the execution of a specific task? - What does the integration of BPMS with social software entail for the concept of activity/task modeling?
Behavioral Perspective	- How should the notions of social interaction and social production be interpreted in a BPMS environment? - How could social software features, promoting participants' creativity and innovation be integrated with typical BPMS controlled flow of the executed processes, so that advantages from both sides are exploited? - What kind of motivation mechanisms should be established to encourage proactive contribution of process participants, even if they are not obliged to do so? - What kind of process modeling approach would be appropriate for describing the alternative way of working for process participants, arising from blending BPMS with social software? Would it be meaningful to execute process patterns to some extend or merely use them for recommendation purposes? - How should existing technologies from both software types be combined for the development of a hybrid system that ensures flexibility and enables effective knowledge management and efficient collaboration? Would the existence of a workflow engine be of any value for such a system? - Would business process lifecycle holds as is or a reconsideration of it would be necessary?
Organizational Perspective	- How should the structure of the organization (e.g. positions and responsibilities, policies) be represented within the environment supporting knowledge-intense processes? - What is the degree of freedom that actors should have in the execution of a business process? - What are the implications of combining BPMS with social software for the concept of role? Should it be modeled in an alternative way to accommodate additional semantics?
Informational Perspective	- How could the creation and sharing of metadata as part of folksonomies be supported in a BPMS environment in order to promote knowledge elicitation during process enactment? - Would it be useful for knowledge-intense processes to loosen the semantics of activity input and output? - How could the experience of participants fulfilling a goal or participating in completing a process instance be transformed to knowledge available to others having similar needs? - How can content quality, trust and reliability be ensured in a hybrid environment adopting features from both social software and BPMS?

Furthermore, one should consider omitting or reducing the semantics of data serving as activity input or output. Since information may be classified based on an ontology or folksonomy within a specific context, such as scientific field, administrative domain or language [50], a knowledgeable actor may identify semantic similarities between them, loosening the strict relation between activities input and output dictated by typical BPMS environments. Such a feature might promote flexibility in the way activities can be composed to meet a specific objective.

In social computing, participants receive recommendations, based on other participants' actions or experience [46]. When the actor is not obliged to follow a strict flow of activities, the experience of others may help in choosing what to do. In such cases, evident in knowledge-intense processes, the BPMS environment should provide for the transformation of past participants' recorded experience to knowledge available to those facing the same or similar situations [40].

Finally, it should be stressed that the uncontrolled creation of content from the social media has its own issues of trust, content quality and reliability that should be taken into account when considering it in a business environment [51].

Table 2 summarizes the identified issues for each perspective.

4   Conclusions – Future Work

Embedding social software features in BPMS seems promising for effectively supporting knowledge-intense processes. However, this amalgamation raises several important issues. In order to identify and address such issues, we structured our findings according to the modeling perspectives proposed by Curtis et al. [24]. These perspectives were used to juxtapose attributes from both software types. From the analysis conducted in this paper, it is ensued that the solution to effectively support knowledge-intense process execution within an organizational environment, might lie somewhere in-between the two software types, blending features from both of them. Coming up with an effective and efficient solution is a major research issue, presumably affected by process- and enterprise-specific parameters. In other words, the solution may vary depending on the characteristics of the business process and the enterprise in concern. The list of the identified issues is not exhaustive. However, we believe that examining the integration of social software with BPMS in respect to the specific modeling perspectives can help researchers in further identifying related issues, so that they can contribute to the incarnation of an effective solution for efficiently supporting knowledge-intense processes.

Future work targets at the prototypical development of a hybrid environment integrating social computing features into a BPMS engine for the efficient execution of knowledge-intense processes. Given the issues one should consider, a first step towards this direction is the identification of the appropriate modeling approach to activity execution, the integration of networking and communication features to co-ordinate activity executions and the introduction of participant profiles to describe the characteristics of knowledgeable actors.

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