A Conceptual Framework for Social Business Process Management

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Abstract

Over the recent years, Business Process Management (BPM) paradigm has become more socially driven. The socialization of processes has become an unavoidable way to realize flexible processes by including means to improve collaboration, knowledge sharing and collective decisions. However, the majority of current proposed approaches are limited to the exploitation of social technologies (social networks, blogs, wiki...), without providing a coherent conceptual and reusable framework, independent from those technologies. This paper defines precisely the social dimension to be taken into account in BPM and recommends a set of models to structure the design and development of Social BPM. In addition, a social ontology has been developed with Protege 5.0 and rules for inferring knowledge and queries for exploiting it have been implemented with SWRL and SPARQL.

Keywords: Business Process Management (BPM), Social Dimension, Ontology.

1. Introduction

Advanced process-based applications such as risk management, virtual organizations, and factories of the future are subject to frequent changes. Sometimes, processes involved in such applications are not completely defined at the beginning of their deployment and they require the intertwining of design and execution phases while the process evolves. In fact, these types of processes not only requires flexibility to adapt to changes but they also should include means to ease collaboration, knowledge sharing and collective decisions to make the process converge towards the actors' common goal. In addition, all these requirements should be taken into account over the process life cycle. For example, users could be involved not only at design time to make a decision about the process but also at run-time to guide its execution or to perform tasks.

If we examine traditional BPM systems and approaches, we can notice that most of them do not meet these requirements and suffer from the following limitations:

- *Deviation and lost of innovation:* end-users of processes (actors) are different from their designers and there is no communication between these two types of actors. This problem leads to a deviation between execution

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and design models, and decreases innovation by a lack of communication. This problem is also referred as the model-reality divide. A design participative approach with knowledge sharing of those actors could help in solving these two problems.

- *Lack of visibility:* Most of BPM tools allocate a task to an actor according to standard access control policies (e.g. role-based access control) and the actor is isolated and has no global visibility on the process. Users are aware of *what should be done?* but ignore *what can be done?*. Providing them information about *what can be done?* could lead actors to perform the more appropriate tasks. However, we can mention the case handling approach of Adams et al. [12] to deal with the issue.
- *Lack of Cooperation:* The user has no support from the system to be assisted in his tasks in case of difficulties such as overwork or lack of individual skills, resources or information. What could be useful is means to interact with collaborators in order to ask for information, to delegate dynamically tasks to volunteers, to call for proposals, to launch decision processes for solving indeterminism in the case of choices, and so on. Interactions followed in such mechanisms could be informal or compliant with strict rules or protocols (vote, negotiation...) leading to commitments.

Regarding the state of the art, three types of works exist. The first type only couples BPM systems to social technologies without providing theoretical backgrounds or models to have reusable solutions. The benefit of this coupling is difficult to measure. The second type provides frameworks for defining social relations between homogeneous objects (actors, machines or tasks). These social relations ease the coordination between considered objects. Even if the idea is interesting and improves the efficiency of the organizational aspect, no conceptual model is provided and the relations between different objects remain static; they do not integrate interaction protocols (vote, negotiation, call for proposal...) as it could be the case in real life. The last type of work focuses on the allocation task procedure and tries to improve it by providing deontic modalities (such as obligation, permission or prohibition). This mechanism empowers the actors, structure their relations and rules their coordination. However, a limited attention has been given to formal models while existing formalisms such as deontic petri nets could be used to provide solid backgrounds to this solution. In conclusion, existing works do not provide a comprehensive framework to address the integration of BPM and social dimension coherently. Moreover, they do not cover the process life cycle and only few of them provide reusable models.

Giving all these observations, the aim of this work is to propose a new approach integrating suitably social concepts into BPM to provide efficient Social BPM systems. This approach includes a conceptual framework to support modeling, development and execution of such systems. This model is organized around reusable and conceptual basic bricks corresponding to protocols, social relations and constraints. The originality and the advantages of our proposal are i) the definition of a social meta-model suitable for the field of the Social BPM and independent of any social technologies ii) the possibility of re-using components of the model iii) possible rule-based-reasoning on this meta-model represented by an OWL ontology iv) innovation, visibility and cooperation improvement.

To illustrate the different aspects of our work, we consider crisis and disaster management situations where formal plans/processes can be followed and where the social dimension is of a paramount importance. Indeed, crisis and disaster management involves several stakeholders, each one having its own knowledge and procedures and internal organization, but all together should take part of a collaborative process in order to achieve their common goal: the crisis resolution. Some of the stakeholders could be official partners, while others could be NGOs that dynamically integrate the group. Also citizens can become a first class partner through socio-media by providing useful information and services.

The remainder of this paper is organized as follows. Section 2 provides our social meta-model. Section 3 presents the ontology corresponding to this meta-model. Section 4 describes related works. Finally, we discuss our approach and conclude the paper.

2. Social BPM Meta-model

In order to engineer social business processes, we need a conceptual model of them. This conceptual model represents the main concepts useful for handling processes namely the behavioral, the organizational and the social perspectives of the processes as well as their links (cf. Fig. 1).

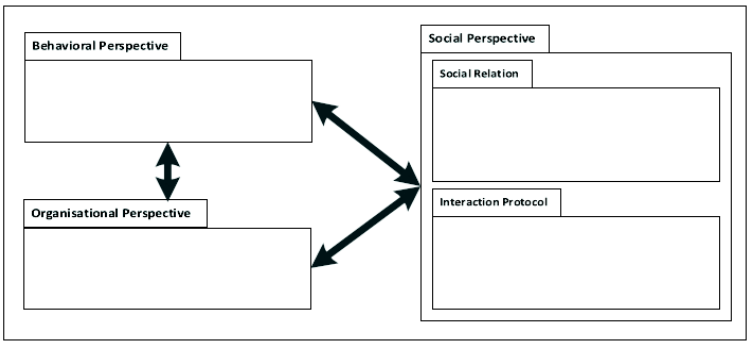

Fig. 1. process perspectives

We present in UML each perspective and the links between them. While the behavioral and organizational aspects exist with other forms in previous works, the novelty of our work is to include the social perspective, made of social relationships and interaction protocols, as well as to link this social perspective to the existing ones.

2.1. Behavioral perspective

The behavioral perspective describes for each process, its goal, its component tasks and their coordination. We do not provide an explicit control structure of the process, however but this former could be deduced by the interdependencies between two tasks as shown in Fig. 2. We can distinguish three types of interdependencies: *facilitate*, *require* and *impede*. While process and task are design concepts, case and activity are concepts related to execution. A process can give rise to several cases, and a task to several activities. We have included the goal concept inside this behavioral aspect, even if in some works this concept is included in a specific perspective, namely the intentional perspective. Let us illustrate interdependencies relations (facilitate, require and impede).

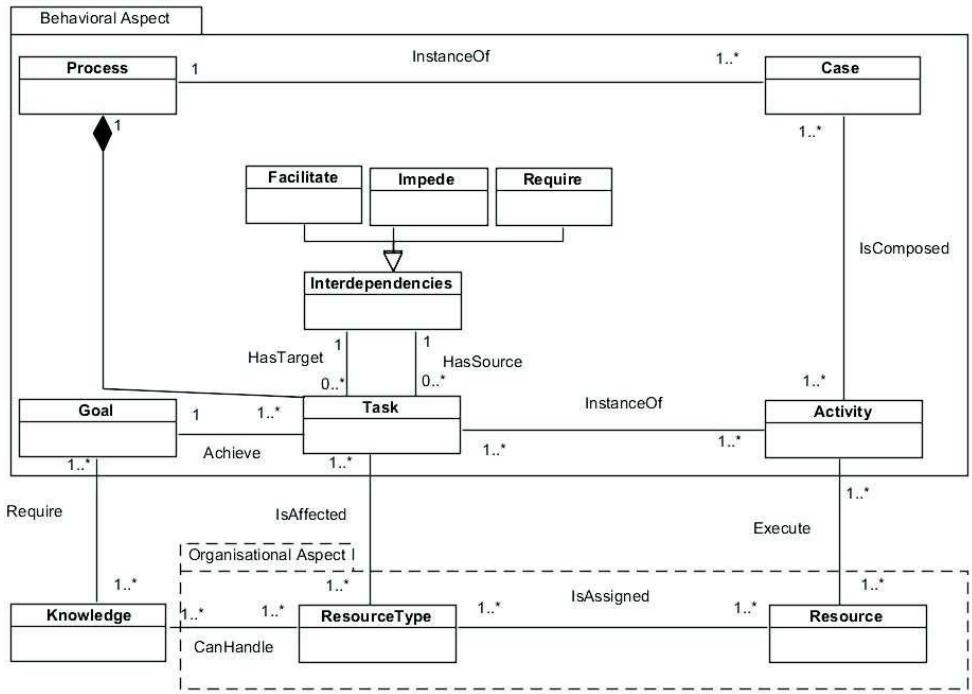

Fig. 2. behavioral perspective

In crisis and disaster management, the evacuation of the population could be facilitated (possibility) if the cleaning of the roads by the equipment division and the cessation of traffic by the police are performed before. At its turn,

the cleaning of the roads could be facilitated if a helicopter provides an accurate picture of the current state of the road to be cleaned. The evacuation task requires (obligation) to have estimated the number of injured people before. The task of providing a picture by helicopter impedes the task of transporting injured persons by the same helicopter. Each time two tasks have to use simultaneously the same resource, there is an impede relation between them, which can also correspond to mutual exclusion. In addition, each task taken individually has it own goal but we also record the global goal of a process. Note that the knowledge class defines the know-how and expertise (different from tasks) required for reaching a goal and/or handled by a ResourceType.

2.2. Organizational perspective

The organizational perspective answers the question *who does what?*. It aims at describing how a set of resources should be configured to perform a business process. In our model, ResourceType defines a set of resources with shared characteristics: a role or a group (department, team, office, organisational unit). A role is a position within an organization that can be taken by a qualified resource, which becomes endowed with specific rights and is expected to achieve a particular goal. A resource is an entity that is involved in the execution of an activity. It may be a human, a machine or a software. Each ResourceType is assigned to its Norms corresponding to rules that define how to use the resources (permission, prohibition or obligation). These Norms can be seen as constraints that extend (permission) or limit (prohibition, obligation) the space of actions within processes. In existing works, like Combettes et al. and Hummer et al., rights are defined in a static manner and no possibility is offered to modify them. On the contrary, in our proposition dynamic rights definitions are allowed: adding supplementary rights for ResourceType or specifying ExceptionalNorm for some actors without changing their roles.

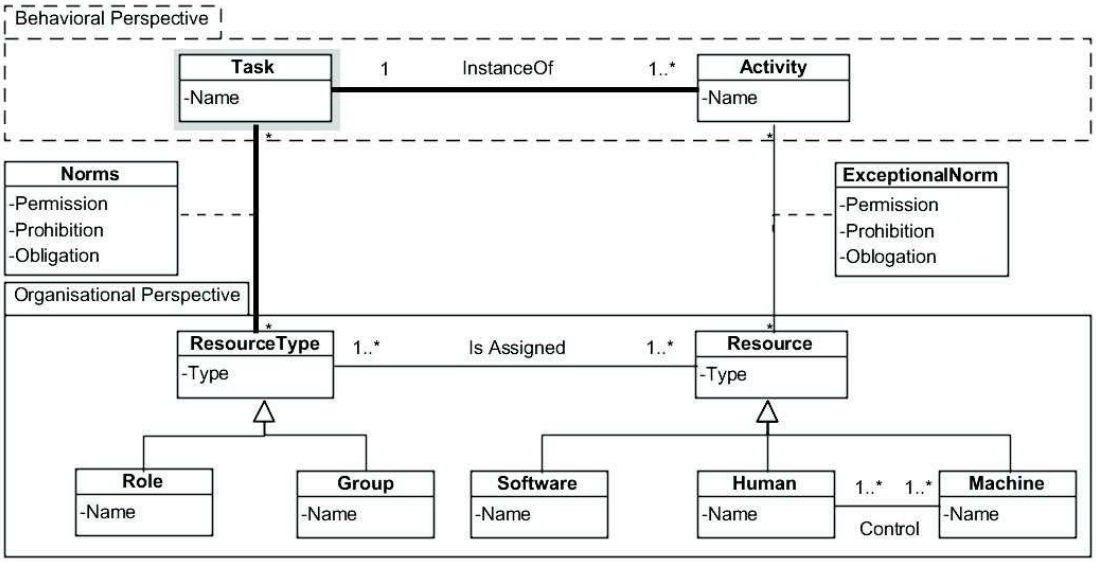

Fig. 3. organisational perspective

Actors are essentially the central resources in a business process, which may establish and maintain relations among them. Taking into account those relations implies the definition of transition mechanisms from the organisational level to the social level, which allows for the expression of those relations among actors.

2.3. Social perspective

Social aspects in business processes are ambiguous or lacking in most research works, where a process is defined simply as coordinated tasks achieving a common goal. These works ignore most of the social aspect of the process, such as human formal relationships (power, control, coordination), how they could or are allowed to interact, and according to what protocols. All these aspects are important since they ease coordination (Noriega 2015) and therefore improve process efficiency. We define such a social model independently from any technical considerations.

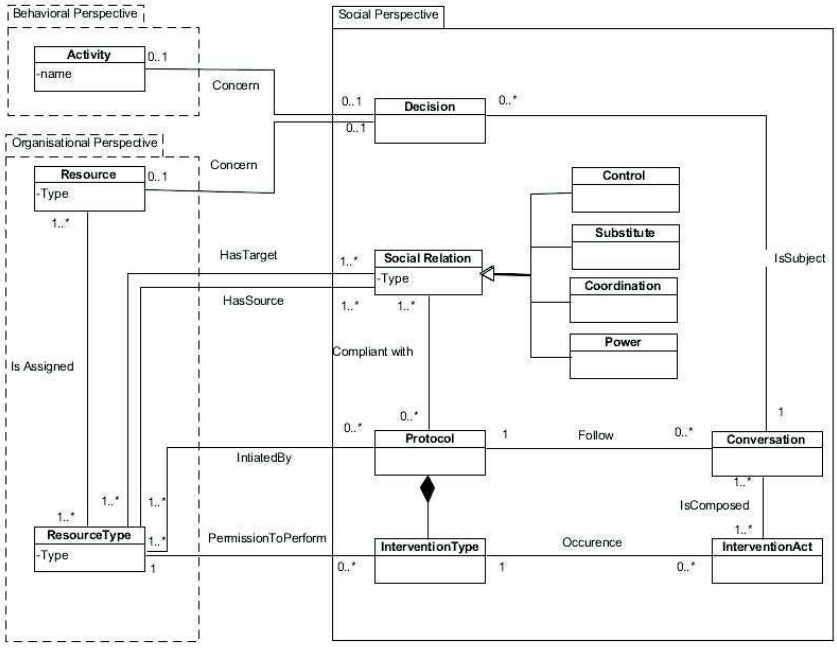

Fig. 4. social perspective

As expected, in our meta-model (cf. Fig. 4), we define two main social concepts:

- Social relations among ResourceTypes define a social network as a graph where a node represents a ResourceType (role, groups) and an edge, a dependency among a source and a target ResourceTypes. A dependency represents a control, a power, a coordination or a substitute relation.
- Interaction protocols (e.g. call for proposal, vote, negotiation) specify a set of rules that govern the interaction among resources of a given type. Actors' interactions are a crucial point for the control and the flexible execution of processes. A conversation is a process that follows the rules of a Protocol, so that it may be considered as an instance or an occurrence of this Protocol. A conversation mainly consists of a set of InterventionActs. An InterventionAct is an occurrence or a performance of some InterventionType. Each InterventionType is linked to its possible performer i.e ResourceType. The purpose of these conversations is to make decisions about the design and/or execution of processes, i.e. choosing, sub-contracting adding, deleting, modifying an activity and/or finding new partners in case of insufficient or failing resources. A great variety of protocols may be described from this conceptual schema and it is not tied to a physical implementation or tool.

Let us illustrate our meta-model through a real-world example. As shown in Fig. 5, French crises managed at the national level involves actors at four different levels. People involved in crises resolution are the Minister, responsible at a national level, the Prefet, responsible at the regional or departmental level, leaders of the troop (fire chief, police chief, SAMU chief) and actors acting on the ground (extinguishing the fire, stopping the traffic, transporting injured persons...). Between these various actors, we can distinguish four types of relations: power, coordination, control and substitution. *Power* enables a superior to delegate tasks to subordinates. In our context, the Minister delegates the resolution of the crisis to the Prefet who himself, following a process/plan, delegates tasks to each leader. In turn, each leader will order to his team members to perform tasks in which he maintains the *control*. *Coordination* links correspond to information exchanges. Finally, comes a *substitution* relation, which expresses that certain actors could replace others when there is a lack or a fail of resources. For instance, a possible substitution relation exists between the firemen and the SAMU in particular for transporting injuring people. This graph could dynamically evolve in real time. For example, citizens could be integrated as a first class stakeholder if their role through socio-media becomes relevant. In particular, the minister or the prefect may have to communicate recommendations via the media and the

citizens give their opinions, express emotions, provide services or testimonies.

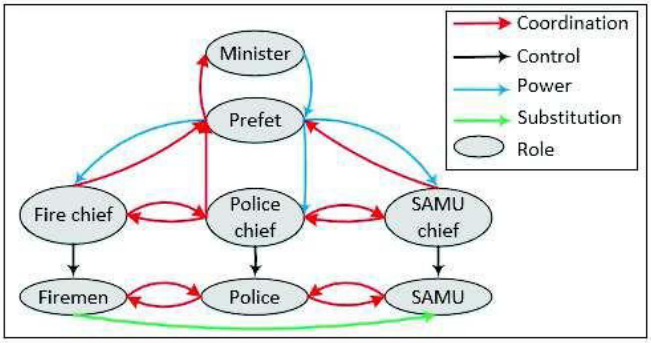

Fig. 5. Social network of resourceType

While the social relations define a link between two stakeholders, their concrete interactions could be informal or following specific protocols. Let us take two examples from our case study. The Prefet can launch a specific call for proposal protocol (e.g. contract net protocol) to select the most appropriate hospital to receive injured people. Experts can vote to determine if the population should be evacuated or not, considering the level of gravity of the situation, each expert having its own measure of the gravity and its value could differ from one expert to another.

3. Social Ontology

To put the previous meta-model in action, we need a representation on top of which querying, reasoning and deduction are possible while intertwining processes design and execution. Moreover, we have to pay attention to the fact that business process modelers and users often misunderstand BPM concepts, due to a lack of knowledge on this domain. This semantic problem impacts the efficiency and quality of business process modelling and enactment. Thus we believe that a shareable and semantically rich specification of the universe of discourse will help the actors involved in business processes to understand how their processes proceed and how they can adapt them dynamically. To this end, we define an ontology that not only describes a machine-readable definition of concepts involved in the three perspectives of our meta-model, but also enables rule-based reasoning and deduction. We use for that a Semantic Web Technology combining OWL (concepts description) and SWRL (deduction rules). The use of an ontology has additional interesting advantages: a high degree of expressiveness, formal background and interoperability. To construct our ontology, we have represented all the concepts described in our meta-model (Process, Goal, Protocol, Social Relation, Task, and so on.), and defined new rules to help actors involved in the process to dynamically build and adapt the process by querying the ontology and deduce knowledge on top of it. Fig. 6 illustrates our key Social Ontology concepts, defined in OWL, including processes, norms, social relations, tasks, resources, among others.

Using this ontology, we can query instances (creation, deleting, updating) or build rules to deduce not explicitly recorded knowledge from the ontology. We use a first-order logic to describe objects of our ontology and rules handling them. Here, we only illustrate how queries and rules could be used for cooperation and visibility.

3.1. Querying the ontology with SPARQL

We give bellow some example of queries for exploiting the Social Ontology.

- Q1: Which are the tasks that allow one to reach a given goal?

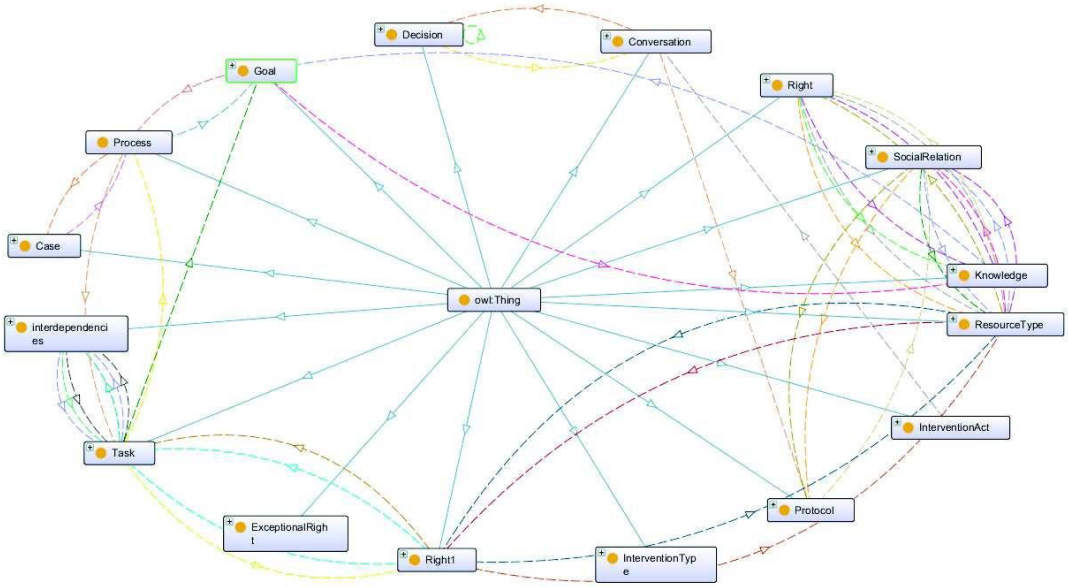

Fig. 6. Hierarchy of schema graph of our ontology

```
SELECT ?Task ?Goal ?name
WHERE {?Task :isTaskOfProcess ?Process .
?Task :hasTaskGoalrelation ?Goal .
?Goal :nameGoal ?name
}
```

- Q2: Who can be substituted to who for a certain task?

```
SELECT ?roleA ?roleB ?task
WHERE { ?roleA :substitute ?roleB.
?task :taskResourceType ?roleA
}
```

- Q3: Protocols that are linked to the coordination social relationship?

```
SELECT ?protocol ?type
WHERE  ?protocol:hasSocialRelationProtocolRelation ?target.
?target :Type ?type
FILTER (?type = "Coordination")
```

3.2. Rules for deducing knowledge

We present hereafter some interesting rules that help actors involved in a process design and execution to have a visibility on the different perspectives of the process.

- Q1: Determining the transitive closure of the delegation relation. The power relation defines a link between two persons and determines a delegation right. It could be interesting to know all the hierarchical path in terms of delegation between two given persons. In the following, rule a person ?x can delegate to a person ?y if x has a power relation with ?y or if ?x has a power on an intermediary ?z who has a delegation relation with ?y.

$$\boxed{\begin{array}{l} holdPowerOver(?x,?y) -> delegate\_To(?x,?y) \\ holdPowerOver(?x,?z) \wedge delegate\_To(?z,?y) -> delegate\_To(?x,?z) \end{array}}$$

- Q2: Different rights of ResourceTypes on Knowledge ?

$$\boxed{\begin{array}{l} KnowledgeResourceType(?k,?r) -> hasKnowledge(?k,?r) \\ \text{hasKnowledge(?k,?r)} \wedge \text{hasKnowledgeNorms(?n,?k)} -> \text{Norms(?n,?r)} \end{array}}$$

Several other information or knowledge can be retrieved or deduced from our ontology, namely:

- Which is the set of activities constituting a particular process? Which is the set of activities that meets a particular goal?
- Who holds the power over who? Who has control over who? Who coordinates with who?
- Which roles a particular actor can perform?
- What are the permission, prohibition and obligation of a particular actor?
- What are the relationships between tasks?
- Who are the actors that own knowledge necessary for a given goal?

4. Related Works

In this section, we compare some important existing works about social BPM regarding the four requirements discussed in the introduction, namely cooperation, innovation, visibility and deviation.

- *Deviation decrease and innovation improvement:* one of the major limitations of traditional BPM approaches is that they prevent the users from sharing knowledge and participating to the process life-cycle enactment. Indeed, using access rights, each performer has only a view of his allocated tasks and process modification is only possible for designers. Users are not aware of the whole process structure and are not involved in its evolution and adaptation. Moreover, according to Yiwei et al.[9] innovation can be eased by enabling different stakeholders (based on their responsibility, interest and/or knowledge) to have access to experts and allowing them to contribute, participate and share their knowledge. The authors argue that, by putting all the skills of the experts on a social platform, deviation could be decreased and innovation improved. However authors do not give means to coordinate all these numerous actors and this could decrease the process efficiency and raise security problems notably in domain such as crisis and disaster management. In our work, these drawbacks are limited thanks to protocols that rule the interactions between the different actors. An expert can be, for example, involved only in a specific protocol (vote).

  To improve innovation in a collective way, Santorum et al.[11], suggest to use a participatory approach that allows different stakeholders sharing the same interests, for creating groups and sharing their knowledge and ideas. However, they do not deal with deviation as we do it by intertwining process design and enactment.

  The gathering and reuse of knowledge in BPM, for innovation purpose, is also addressed by Ranghia et al.[2]. The authors use social tagging during process design. The process owner records discussions (words and tagging) between end-users and deduces the process from the analysis of these discussions. The drawback of this approach is that it decouples the knowledge gathering phase (collective) from the design one (process owner only). The process owner decides by himself the structure of the process according to his own understanding of the discussions. On the contrary, our contribution provides richer and direct interaction mechanisms (not limited to tagging) and the collaboration is possible in design and enactment phases.
- *Improving visibility:* In traditional BPM, the performers are isolated and have no global visibility on the process. Thus, this induces several issues. We believe that it is essential to have a flexible control on the rights of each actor involved in the design and execution of the processes. Thus norms regulate access to

processes through permissions, prohibitions, obligations. There are very limited works that have studied this aspect in BPM domain. For instance, Natschlager et al.[8] present a deontic classification of tasks. A task can be obligatory, permitted, forbidden, or alternative with respect to others. This work provides a new notation called deontic BPMN to improve the expressive power at design time. Unfortunately, it does not apply these deontic features to actors but only to tasks. In addition Brambilla et al.[3,7] use social technologies (social network) to share part of a process with stakeholders in order to collect their feed-backs and improve the process. However, the work is limited to the design phase and does not provide the control policy of the participations of the actors.

- *Improving cooperation:* cooperation could be used for innovation purposes as discussed above, or for helping process actors in case of difficulties at deign and run time. We present hereafter related works for this latter case.

  Several works have been proposed in order to support (improve) cooperation among the users, according three main categories. In the first one, a participatory paradigm is introduced to enable actors to participate in the design and the execution of the processes. In the second one, social relations are used to capture and exploit the relations among the processes components. The third one, is based on protocols to define a set of allowed actions and how they are can be managed and ruled among the components.

  First, we can mention the participatory approach of Santorum et al.[11] that eases a collective process modelling by means of a social platform namely ISEAsy. The work of Maamara et al.[4] builds a social network among actors to define plan-repair actions to execute when conflicts occur over resources. The social network is exploited to define the better plan and actors to use. All these approaches increase the cooperation between different stakeholders, but no formal meta-model is defined to explain (i) how these concepts are connected to each other, (ii) how those concepts are modeled and integrated into the BPM life-cycle.

  Another way to deal with the cooperation is to use interaction protocols (e.g. call for proposal, negotiation or vote) ruling and structuring the communication between actors. Several works have been proposed in the literature, for instance in Combettes et al.[1], in which a new Petri net-based formalism called organizational Petri nets (OgPN) is introduced. The authors recommend a meta-model for integrating protocols in a organization. This work does not express the social relation among actors defining the context of use of the protocols in a given organization. This point is of a paramount importance, notably in a crisis and disaster management domain, where hierarchy, responsibility, control and coordination relations have an impact on the protocols and the way to be used.

5. Conclusion

The social dimension is an unavoidable way to improve collaboration, knowledge sharing and collective decision in BPM. However, this social dimension is effective and efficient as it is well defined, properly applied and independent from any technology. To this end, this paper presents a social BPM meta-model for modelling and executing processes in a collaborative way. This meta-model includes three interrelated perspectives: organizational, behavioural and social. It takes into account the social relations between actors (power, coordination, substitution and control) and their interaction protocols. We provided an operational representation of this meta-model in terms of an OWL ontology implemented using Protege 5, on top of which rules have been defined to deduce additive knowledge. We have also shown how it could be used in crisis and disaster management. As future work, we intend to build an interface for allowing our system to be accessible in a uniform way through web services and allow users to query the ontology and ease the collaboration between actors involved in the process design and execution. Also, it could be interesting to define a new BPMN extension including our recommended social perspective.

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