PROASIS: As-Is Business Process Model Maintenance

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Abstract. Business process modeling must offer a trustworthy, reliable and updated representation of different enterprise concerns. Nonetheless, it is acknowledged that model maintenance is a difficult task and most of the times modeling efforts in companies are limited to specific projects occurring at a particular time. After that, models just "sit on the shelf". This paper defines an "as-is" model continuous updating process that uses the annotation mechanism to create interaction contexts enabling business actors (1) to communicate and explicit their knowledge about processes and about their own work, and (2) to discuss existing process representations. To support the as-is model updating process in real organizational environment a prototype tool has been developed. This approach has demonstrated that organizational actors, since provided with a process and supporting tool, can act as active updaters of business process models by comparing the modeled with actually executed activities, becoming themselves organizational modelers.

Keywords: Enterprise Engineering, Business Process Dynamic Updating, Annotation, Collaborative Negotiation, Organizational Knowledge, Organizational Self Awareness.

1 Introduction

Enterprise engineering [1] puts together concepts, methods and technologies which allows to understand, model, develop and analyze business strategies, processes and supporting information systems, with special focus on their dynamics and inter-relationships. Enterprise architectures are enterprise engineering frameworks that allow representing organizations from different perspectives where the most commonly used include strategy, process, applications and technology perspectives [2]. Within enterprise architecture frameworks, business process models are used to communicate, document and understand the activity of organizations [3]. The model representing business processes at a particular time, is defined as the "as-is" model. In

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contrast the "to-be" model reflects future changes in processes resulting from process analysis made in the scope of enterprise initiatives (e.g., Business Process Management (BPM), Total Quality Management (TQM), Business Process Reengineering (BPR)). The goals of building as-is models include:

- Redesigning or improve the organization [4], [5], [6], [7];
- Improve enterprise integration [8], [9], [10];
- Act as a starting point to information systems architecture [11] and to requirements gathering in information systems development [12];
- Control the running processes (using workflow management systems, model based process control or business activity monitoring) [4], [7];
- Act as knowledge repository of the organization.

Achieving the latter goal enhances the ability of organizations to become learning organizations [13], [14]. Processes and activities contain all the information about how, when and who does the work flow [15] and constitute the only basis truly verifiable and understandable by organizational actors [16]. This is particularly true if business process models are built by gathering actual actor actions and interactions composing business activities, which in turn are orchestrated in business processes.

Organizational knowledge about activities and processes can be made explicit through business process models built with the contribution of the knowledge of all the individuals working in organizations [17]. This highlights the need of promoting and facilitating the use of this type of models. Business process model repositories may also allow incorporating new knowledge in an iterative and incremental fashion by becoming the subject of conversations among organizational actors. To achieve this it is necessary to understand the interaction dynamics between organizational actors and the interaction contexts created by such interactions.

Business process models can also have a key role in enhancing organizational self awareness. Human beings are self-aware by nature. Organizational self awareness is the result of a conscious process that involves (1) efforts of each individual member of an organization of making sense of their environment and (2) discussions and negotiations among those individual members in order to reach agreements around their "sensemaking" of the environment [18]. At an organizational level, self-awareness is only achieved by a proper understanding and management of the interactions among organizational actors [19]. In order to properly support organizational self-awareness, business process models need on one side to accommodate individual, group and organizational views emerging within personal action contexts, as well as inter-personal and group interaction contexts [20]. On the other side, they must guarantee the consistency of the whole model [17].

Despite being acknowledged as an important asset for knowledge management purposes, empirical studies have shown that the as-is business process model is not continuously updated, because the maintenance of this representation is not straightforward [21]. Currently, the depiction of business process models is limited to efforts including BPM, BPR, and TQM among others, and then "sit on the shelf" [22].

The work presented in this paper aims at defining a process to streamline and automate the continuous updating of business process models in order to maintain their alignment with the actual processes and activities being executed, using (1)

annotation and (2) collaboration mechanisms. This work argues that if as-is models could be updated continuously by incorporating individual knowledge and enabling discussions and negotiations among the contributing individuals, they could be used as a permanent repository of organizational knowledge and therefore, could be a basis to support and enhance organizational self awareness.

More specifically, this work has the following research goals:

- Definition of the updating process model of as-is business process to keep the alignment between the model and actual execution, recognizing organizational actors as key players in the process to reduce the gap between the actual of operation of the organization and its representation.
- Development of a supporting tool, suitable for use in real organizational environment.
- Definition of an mechanism for making explicit the misalignments found
- Extending the previous mechanisms by allowing a communication channel between the actors (the part) and organization (the whole). In order words, allowing the discussions of private and incoherent views expressed in graphical or textual representations of the organization to enable the construction of shared representations.

The remainder of this paper is structured as follows. Section 2 describes the theoretical background supporting our approach. Section 3 summarizes related work on other collaborative business process modeling tools. Section 4 defines the as-is enterprise model dynamic updating process. Section 5 presents the supporting tool prototype developed. Section 6 presents a case study set to use the defined process and tool in real organizational environment. Section 7 presents our conclusions and future directions.

2 Background

The present research aims at giving contributions to enterprise architecture and business process modeling disciplines, and is supported on theoretical and practical concepts coming from other disciplines including organizational, management and social sciences, as well as software engineering. This section summarizes the state of the art on enterprise architectures and business process modeling, the contemporary paradigm of organizational science and some related theories, Haberma's theory of human communication and an enterprise modeling approach supported by them. The annotation mechanism used in updating software engineering processes is presented. Finally, related work about collaborative business process modeling tools is summarized.

2.1 Enterprise Architectures and Business Process Modeling

The concept of enterprise architecture has a key role in giving the meaning of the organizational whole, while respecting the independence of the various perspectives of its constituent parts. According to Schekkerman [2], enterprise architecture is a full

expression of the companies that acts as a collaborative force between business aspects: operational, organizational, structure, business terms, processes, data and automation.

To Lankhorst [23], Enterprise Architecture is a comprehensive set of principles, methods and models used in the design and implementation of organizational structure, business processes, information systems and technology infrastructure.

There are several frameworks for Enterprise Architecture, some more specific and some more general as it may be applied to any organization. The CEO framework [11] and the Zachman framework [24] are examples of the latter ones.

One of the most important features of Enterprise Architecture is the possibility it gives to minimize the misalignment between the various components of the architecture, thereby minimizing enterprise misalignment as it relates to strategy, processes and activities, organization, information, systems and technology [2].

According to Whitman [25], the business process model is a symbolic representation of the organization and things that the organization is dealing with. Fox [26] gives a more detailed definition because he defines the business process model as a representation of the structure, activities, processes, information, resources, people, behavior and restrictions of an organization. The model of business processes allows a view of the organizations at the operational level. The business process model of an organization, according to Giaglis [27], focuses on identifying the activities that compose each process by defining the workflow between them and where they are performed and identifying the resources used in each activity.

The elicitation of business process models means to extract information from current business procedures and existing applications and encode them formally. A business process model should be able to provide several pieces of information to its users. These elements include, for example, which activities compose the business process, who performs these activities, how and why are implemented, and what informational elements manipulate. Any modeling technique should be able to represent one or more of the following modeling perspectives: functional, behavioral, organizational and informational [27].

From the organizational knowledge point of view, the business process model can be characterized as:

- A facilitator of knowledge creation and sharing [14].
- An enabler of the evolution of tacit knowledge (individual) to explicit knowledge (organizational), as it allows the use and sharing of knowledge, driving the creation of new knowledge [28].
- An implementation of the organization media, through private images and public maps and a representation of both the individual organizational image and the whole organization, allowing individuals to know their place in organizations [29].
- A simulation of hypertext organization [28], since it can be implemented with multiple navigable layers, including the layer of individual views (business system layer), the layer where these individual views are articulated and fit (project team layer) and the layer of the general model, containing a unique global view of the organization (knowledge layer). These layers must be aligned in real time to ensure consistency and integrity in representation.

- A representation of two theories of action of Argyris and Schön, the professed and implemented (and therefore have to have sensors that capture the action implemented, that collect and analyze the consequences, allowing the redesign of governance variables and strategy of action) [29].
- A basis for monitoring the very complexity of the model using simple modeling primitives (Entity, Role, Context, Activity) [30].
- A platform to promote the updating of the model itself, by detecting the misalignment between reality and representation of reality using annotations [31].

There are several notations and methodologies to model business processes. BPMN and DEMO are, respectively, examples of a notational language to model business processes and a methodology to model organizations (and business processes as well).

BPMN. Business Process Modeling Notation (BPMN) is a standard graphical notation for representing business processes and was originally developed by Business Process Management Initiative (BPMI) which merged later with the Object Management Group (OMG), an entity that now manages its development cycle.

The main objective of BPMN is to provide a standard notation that can be read and understood by all stakeholders of organizations, including business analysts, programmers and managers [32]. To achieve this objective, BPMN was created as a lingua franca, bridging the gap between process design and implementation. Another objective of BPMN is to ensure that the language (XML based) developed for the execution of business processes can be viewed with a business oriented notation.

DEMO. DEMO (Design and Engineering Methodology for Organizations) meta-ontology is used to develop ontologies that must meet some requirements that cover important properties of ontologies [33], of which the following can be highlighted: It should clearly distinguish, based on solid theoretical grounds, between the world (states and events) and the causes of change in this world (actors and acts). Ontology is about the comprehension of the essence (which means the nature or being of things) of something. Nowadays and beyond the original meaning, enterprise ontology have also a practical goal because it serves as a basis of common understanding in a particular area of interest [34]. So, enterprise ontology is the specification of the conceptual model of the organization essence, independently of its implementation [33]. This conceptual model should be coherent, where the several aspects of the model can be distinguished, without losing the notion of the whole, comprehensive, in which all relevant issues are covered, consistent, where the models are free of contradictions and irregularities, concise, containing no superfluous questions and only showing the essence of the operational enterprise model, avoiding all the implementation and realization questions [35], [36]. For each organization there is only one ontology that shows the essential activities of business, the players involved and the products and services that they are dealing with.

The complete organizational ontology is composed by four models. The construction model (CM) specifies the composition, environment and structure of an organization. The CM is expressed by the actor transaction diagram (ATD) and by the transactions result table (TRT). The action model (AM) specifies the action rules that

govern the actors in order to handle their agenda. The state model (SM) specifies the legal states of the c-world and p-world. The SM is expressed by the object fact diagram (OFD) and by the object property table (OPT). The process model (PM) specifies the legal event sequences in both worlds by stating the atomic process steps and their causal and conditional relationships [33].

The only concern of ontology should be on the essential aspects of production and communication in an organization and not on how actors communicate (matters relating to implementation). The notion of ontology system aims to understand the essence of the construction and operation of an organizational system.

2.2 Organizational and Social Theories

Classic approaches of organizations are positivist, i.e. they hold an objective view of reality. Nevertheless, this classical paradigm is being replaced by a new one that regards reality as something that is negotiated and constructed by people's interpretations of what happens around them [37]. Consequently, the contemporary position held on the organization is identified as constructivist. In constructivism, reality is neither completely objective nor subjective. Rather, is it objectified, that is, it is constructed in a way that makes it seem objective. Contemporary views are centered on how organizational agents continually (re)create and change the organization. Constructivist theories argue that organizations exist largely in the minds of organization members in the form of cognitive maps, or images. In talking about organizations and designing maps of it, they are reified, that is, they are made real. Hence, the existence of shared maps requires social agreement and cooperation.

Organizations are also currently regarded as complex systems [38]. Bohm [39] argues that in every complex system there are hidden processes below the surface of reality, which explain the world stage at any time. The author addresses the study of systems that exhibit non-linear behavior (as opposed to cause-and-effect behavior). Complexity introduces notions such as self-organization and emergence (as opposed to deterministic motion), chaos and unpredictability (as opposed to command and control), or sensemaking and understanding (as opposed to rationalizing and predicting).

Another important concern of the constructivist paradigm is organizational evolution. Axelrod and Cohen [40] have taken the principles of complexity and evolution and have put together a conceptual framework for analysis and (re)design of social, political, and organizational systems. The authors call it a 'population approach to complex adaptive systems' given the special emphasis it places on populations. Change in populations result from assessing the performance of the strategies of the agents in the population, according some to measure of success. Whereas successful strategies will be repeated (or copied from another agent), unsuccessful ones will be changed or eliminated altogether. Selection is the result of mechanisms such copying, changing or combining strategies. When a selection process leads to improvements, then selection leads to adaptation.

Finally, the new paradigm emphasizes the notion of agency. In order to be fully understood, agency must be regarded at collective and individual levels. The conceptual framework of Axelrod and Cohen [40] addresses agency at organizational and societal levels. Structuration theory [41] explains the role of agency in the

(re)production of societies. Activity theory (AT) [42] analyzes the formation and evolution of activities, and human consciousness. The organizing unit in AT is the activity, and agents are individuals and groups.

Innovation and knowledge creation can emerge from the interaction of organizational actors groups [43]. It is noteworthy that this position shares the basic assumptions of the contemporary paradigm of organizational science, which highlights the importance supporting interactions among human agents in managing any business process.

Regarding human interactions it is essential to understand the assumptions and rules they use to communicate. According to the theory of communicative action the inherent aim of language is to reach understanding and bring about consensus among individuals [44]. The primary function of speech is to coordinate the actions of several individuals, and to allow interactions to unfold orderly. Speech fulfills this function because the meaning of utterances rests on reasons. This view is called, 'the validity basis of meaning', where validity means a close relation between reasons and consensus. Validity claims are always understood to have been made in the act of speaking. When the hearer rejects the validity claim of the speaker, the communication breaks down and the communicating agents change from action to a discourse situation. Discourse is communication that reflects on the disrupted consensus in an action situation, and aims at reaching rationally motivated consensus. Discourse picks up in the common practice of argument and justification interwoven in everyday life. Discourse is the default mechanism in regulating everyday conflicts within modern societies. In short, Habermas argues that the social order of modern societies rests on the basis of communicative action and discourse.

This theory is important to understand how organizational actors can reach agreements and consensus on representations of their activities, expressed through business process models. Zacarias [17], proposes a conceptual model based on the aforementioned theories centered on agents and their contexts as a complementary perspective to the current perspectives of enterprise architecture (process, information, applications and technology) to enable the alignment between the structure and behavior of enterprises defined in existing perspectives with the actual behavior of its human agents. This conceptual model uses the three agency layers defined in agent architectures (execution, coordination, change/learn) and defines contexts according each agency layer. In the execution layer, contexts are regarded in terms of recurrent actions as well as action and interaction patterns. At the coordination layer contexts are regarded in terms of commitments resulting from agent interactions. At the change/learn layers contexts are regarded in terms of the rules that both enable and restrict the changes that can be made to action and interaction patterns. This work also makes and instrumental use of the concept of context at the execution layer in defining a methodology for the alignment between agent and business process perspectives, The proposed methodology encompasses (1) capturing agent actions and interactions, (2) discovering personal and inter-personal contexts by grouping related actions and interactions, (3) uncovering action and interaction patterns within such contexts and (3) assessing the alignment between contextual actions and interaction patterns with activities composing business process models.

2.3 Annotation Mechanism

In general, annotations are an addition of information on a particular section of a document or other informational entity. Annotations have specific uses in distinct areas: in biology for genome annotation [45], in law science for annotated versions of legislation books, in language science for linguistic annotations, in programming languages like Java [46], in modeling languages like UML [47], in Web pages for analysis of documentation [48] and for adding comments, explanations or other external reference [49], in hypertext for establishing new connections, interpret materials and promote the creation of structure or content, increasing the body of inter-related material [50]. Annotations should capture the activities, resources and the context involved. The continuous improvement of processes requires that the experience captured should be continuously incorporated into business processes and portrayed in the as-is model. The systematic capture and storage in the context where the experience was captured has three major benefits [31]: the experience can become explicit; the experience may be incorporated in the description of the process; the analysis of the experience can be reused in other processes for process improving.

The annotation mechanism used in software engineering to capture the changes (and their justifications) for software projects from the implicit knowledge of development teams [31], seems well suited to be employed in enterprise engineering, namely in annotating business process models.

2.4 Collaborative BPM Tools

According to Borghoff [51], the widespread use of personal computers and associated networks meant that these resources began to be used not only for distributed data processing, but also to work collaboratively, so that, in the literature, the designations Computer Supported Cooperative Work (CSCW) and groupware (software used by groups) were introduced. The term supported refers to the shared data access in a non-coordinated way and to the synchronized modeling of relationships and group interactions. The CSCW designation refers to the research field that was created, and groupware refers to the solutions and tools designed to support collaborative work in practice.

The role of individual members of groups is an important aspect in the development of CSCW tools, because the roles help to structure the interactions between team members and to define the functionalities and access rights of the group. The roles define the social function of individuals in relation to group process, to group organization and relatively to other group members. The roles define rights and obligations in relation to group process.

Ellis [52] defines groupware as "computer-based systems that assist groups of people who share a common task (or common purpose), which provide an interface to a shared environment". The goal of groupware is to support communication, collaboration and coordination of group activities. The group activities are potentiated by a proper and delicate balance between social processes and properly structured technology.

A business processes modeling tool is an automated system that provides capabilities to build business process models [46]. Research on collaborative BPM tools have been addressed by a number of authors.

Gonzalez [53] identifies a set of features necessary to collaborative tools for modeling business processes and analyzes a set of commercial tools to check whether these features identified are implemented. In general most of the tools analyzed provide collaborative features, but many of the features are not present unless, in some cases, all modules have to be purchased, or in other cases, some modules have to be purchased from other vendors.

The requirements of collaborative tools for modeling business processes can be classified according to spatial-temporal matrix of groupware [51] because the interaction can happen at the same time (synchronous) or at different times (asynchronous) and the participants in interaction can be in the same location or different locations. This classification is important to analyze the characteristics of a collaborative tool, since it serves to determine whether the tool covers these requirements or not. After reviewing the available tools, three categories of business process modeling collaborative tools were identified [52]:

- Web tools with modeling support (WS).
- Client / server local tools (CS).
- Export / import Documents (I / E).

Gonzalez [52] analyzed 35 tools from the market for evaluating the collaborative features considered most important, which include: Web Publishing, Model Viewer, Information Reports, Version Control, User Profiles, Comments and Notes, Ability to Disaggregation / Aggregation and other collaborative features not included in the analysis: Notifications to alert the participants that changes were made to the model during the asynchronous work and chat for discussion among participants.

Rittgen [54] suggests that while the modeling literature is abundant, the majority describes the use of notation in a descriptive way, instead of a prescriptive way, because the most common problems that people experience during the modeling process are not issued. Of the descriptive approaches, only a few are dealing with collaborative modeling based on groupware systems. All the others assume the scenario where only one modeling expert creates a formal model. However the following issues should be taken into account:

- The development of a model is rarely done by just one modeler, but by a team that may involve business representatives and people from outside the enterprise.
- The problem domain of business modeling is unstructured and formal languages have a limited use.
- The objective of providing a tool for collaborative modeling requires the identification of detailed stages involved in the modeling process.

Rittgen [54] argues that the process of enterprise modeling involves negotiation conversation type, involving teams (possibly from inside and outside the organization). The modeling process can be seen as a collaborative modeling process, absorbing the benefits of the group decision support systems.

For Rittgen, modeling is a conversational negotiation. To prove this point of view, a modeling experience from which some conclusions were extracted was set up, considering the top four steps of organizational semiotics ladder [55]: syntactic, semantic, pragmatic, and social.

The conclusions drawn from the social and pragmatic levels, through the observation of individuals involved in the business modeling process over three years, are the following:

- At the social level, it was found that social norms among the modeling team are mainly made of rules to determine whether a proposal is accepted or rejected. At this level there are two types of rules: majority and seniority.
- At the pragmatic level, two types of behavior were discovered, and each one can be classified into two subcategories: (1) Understanding, which is concerned with the text of the description of the case or with the modeling language; (2) Organization of the modeling process, which involves two types of activities: setting the agenda and negotiation. Agendas are a tool for the rigorous structuring of modeling sessions, but can be adapted, if necessary.

Most activities at pragmatic level are associated with negotiation. An analysis of workflows at pragmatic level revealed a structure that goes beyond the simple identification of generic activities, so the negotiation process follows a certain pattern (Figure 1).

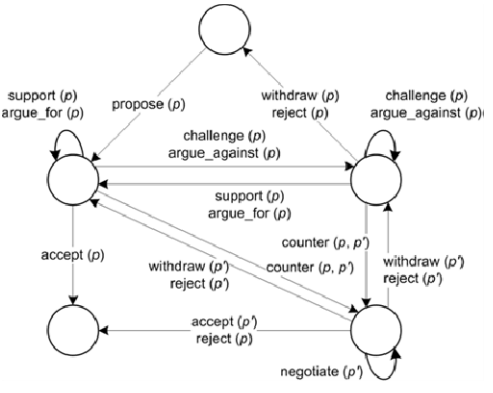

Fig. 1. Negotiation pattern [29]

This pattern consists of an initial and rejection state at the top, in a state where acceptance is favored (top left), a state where rejection is favored (top right), a sub-recursive state to negotiate a counter-proposal (below right) and a state of acceptance (below left). Each of the states allows a certain set of activities that drives the pragmatic negotiations to different states. The parameters that concern the modeler performing the activity and the argument (if present) were left out. In general, any modeler can perform any operation but there are rules that must be observed:

- A modeler that makes a proposal implicitly assumes that he supports it;
- The modeler who withdrew a proposal is the same modeler that originally made it;

- A counter-argument is made by a different modeler;
- A counter-proposal can be done by a modeler or the modeler who made the initial proposal (to accommodate counter-arguments).

Groupware systems for collective sense-making address an important issue in collaborative modeling and can be used as the core of a support modeling system There is a need to implement a component of negotiation that facilitates the structuring of arguments and decisions regarding modeling choices. The model shown in the figure 1 can serve as the initial workflow that controls the negotiation component.

3 As-Is Business Process Model Dynamic Updating Process

The As-Is Business Process Model Dynamic Updating Process proposed in this work is based on a set of assumptions, which result from the reviewed literature on organizational management and organizational sciences, enterprise architecture and business process modeling, that is summarized below.

The operation in organizations is described in terms of processes and activities where the processes are composed of activities flows. Activities are an abstraction of what the organization does. The definition of activities in these areas involves shared understandings about their objectives, resources consumed and produced, roles and procedures involved. Enterprise architecture has several perspectives (strategic, organizational processes, information, application, technology). In the process perspective there are several levels of representation (operational, management, knowledge). The as-is process model represents the operational level of the organizations at current time. This model consists of business processes model and the organizational model (organizational chart).

Organizations are complex adaptive systems created and maintained through the interactions of its organizational actors. Organizational actors are the individuals, which can form groups of individuals, working in organizations, which in turn are also complex and adaptive entities with capacities to act, monitor, analyze, learn and change (themselves and the organization). The implementation of activities is constrained by human-social factors such as needs and motivations of the actors involved, the tools as mediators between the actors involved, and shared socio-cultural rules. In addition, activities are subject to constant change. The creation and maintenance of operational processes models involve communication and negotiation processes between the actors involved. A single organizational actor may have several behaviors. Due to their multi-tasking, each actor can have multiple personal contexts and participate in various group or inter-personal contexts. Their behavior is determined by the role played under certain context.

The idea to explore in defining the AS-IS business process model dynamic updating PROcess (PROASIS) is based on the detection of misalignments between the shared model and ongoing executed processes. Misalignments are detected by the organizational actors executing activities belonging to a particular business process. PROASIS allows these actors to use annotations as a mechanism to collect the updates that they want to make. The language used to represent business processes is BPMN due to its simplicity and widespread use [32]. PROASIS is supported by a

groupware prototype tool that distributes the business process model to the organizational actors, and supports the gathering of annotations as well as the underlying negotiation for refining and approving the annotations. This tool supports also the designing of new versions of the models updated due to the annotations, by the organizational actors themselves.

3.1 PROASIS Definition

PROASIS is a support process performed by people (organizational actors) that work in operational business process and share a common representation of that same process. In PROASIS, annotations are used to build updating proposals to the model of a particular operational process model in order to align it with the process perceived by each organizational actor. These proposals aim to make the corrective maintenance of the business process model and can have two objectives: to correct the model or to increase its detail.

After making an annotation on a modeling element (which depends on the level of granularity), a negotiation with the actors who eventually share the same action context may exist. This negotiation/discussion will be made by all stakeholders of the annotated element in order to clarify the original purpose of the annotation. All actors involved in this review should declare the agreement or disagreement with the annotation made to the model element.

After the review of the annotation, the annotation should be evaluated by the actors enabled to do so, having some degree of responsibility on the executed activities or on the organizational actors involved. If the evaluation of the annotation (and any reviews made to it) results in an approval, the changes requested in the annotation could be incorporated in the new version of the process model by the modeler.

Figure 2 shows the structure that (1) identifies the generic activities in PROASIS and (2) shows the negotiation pattern involved in review and evaluation steps.

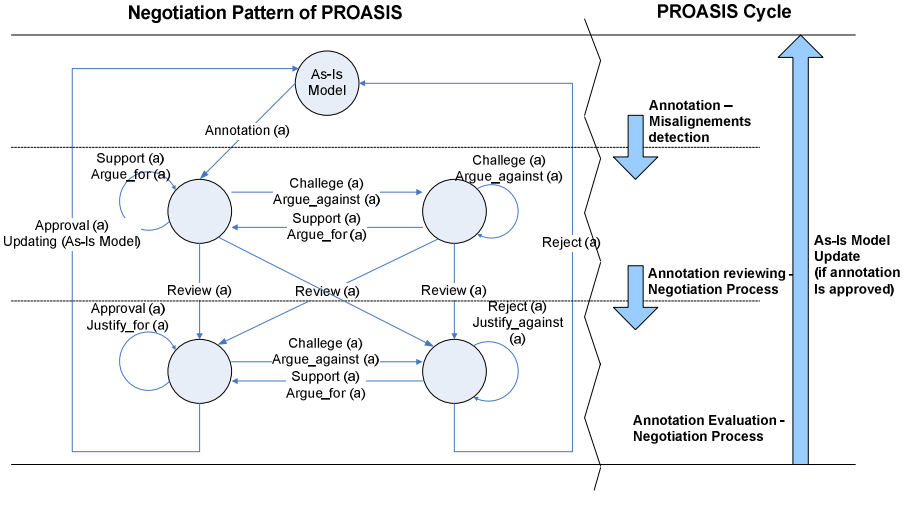

Fig. 2. PROASIS Negotiation Pattern and Steps

This pattern consists of an initial state associated with the as-is model, which can be changed if an annotation is made and then approved in the evaluation step of PROASIS cycle, which involves negotiation. Before evaluation and after the annotation be made, an intermediate negotiation step will be carried out, called review, which should be taken into account in the evaluation step. If the result of evaluation is an approval, it may lead to an updated as-is model through the creation of a new version of the distributed as-is model. This pattern is based on the negotiation pattern of Peter Rittgen [54] used for collaborative business process modeling and which is adapted here for the collaborative updating of business processes (PROASIS).

To define a dynamic update process whose use is as comprehensive as possible, it was necessary to consider the various levels of granularity that a business processes model can provide

The levels of detail proposed by Zacarias [20], which derive from the contexts of the operational model, are considered to support the as-is business process model updating (Figure 3) [56]:

- Process (organizational context).
- Activity (group context).
- Individual actions and interpersonal (individual and interpersonal contexts).

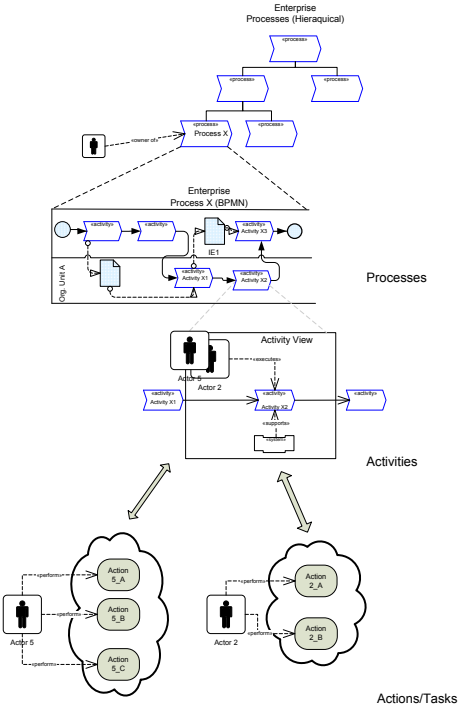

Fig. 3. Granularity Levels of Business Process Model [56]

These levels of detail of the model are related to the architecture of actors (actor, a pair of actors, a group of actors and organizational unit). In this work, the organizational unit is considered an additional level of detail, because the organizational chart is part of the enterprise modeling, and also because the organizational units intersects the representation of activity flows in BPMN diagrams, in which swimlanes typically represent organizational units.

The action level of detail, although considered in this work, is not subject to annotations for updating, because its representation depends on the personal discretion of each organizational actor. In addition other factors were taken in consideration in this decision:

- It is not usually represented in business processes models (e.g. BPMN).
- The context of action represents the set of actions that each actor plays in the organization in order to perform one or more activities, which not corresponds to a shared and homogeneous vision with the same granularity.
- Two or more actors can perform the same activity performing different personal actions, but with the same common goals.
- There may be repetitions of operations of the same actor in the implementation of different tasks, so the cardinality of the relationship between activities and actions is many-to-many.

However, this level of detail is important because it represents the view that each individual actor has about the work he executes in organizational context, and may therefore contain within itself the motive that leads each of the actors to propose organizational changes and updates to common shared models (activity, process). PROASIS do not update the action level of detail, mainly because this level is not a single coherent representation, which can be distributed without ambiguity by all stakeholders of organizations. However, the individual actors who act in the personal and interpersonal action contexts have to monitor the common parts of model and propose changes to implement and incorporate their individual vision in the greater levels of detail. In this way they may give their personal contribution through discussions generated by reviewing and evaluation of the annotations, involving the pairs of actors, groups and organizational units in the updating discussions, strengthening the model role as a common vision at every level of detail presented.

The set of modeling elements and the roles that are considered as standard annotators in PROASIS, can be extracted from figure 3 (table 1).

Table 1. Levels of detail, modeling elements and actors roles in PROASIS

Model	Level of detail	Modeling element	Annotator role
Operational	Process	Process	Process owner
	Activity	Workflow, Activity Informational Entity, Support Information System	Executor
Organizational	Organizational unit	Organizational unit	Organizational unit responsible

The organizational roles of each model presented in the table can take on different roles on PROASIS depending on the modeling element annotated. Note that an annotation is always done by individual initiative in a particular context, involving various actors in the later stages of reviewing and evaluation. This means that the updating context (PROASIS) captures the actors involved in the action context (operational level), consisting in a subset of actors of the operating model - people who participate in the reviewing and evaluation of the annotations.

3.2 Levels of Detail

The levels of detail considered for PROASIS are the same as the as-is business processes model distributed in organizations have. This model is usually composed by the levels of detail described in Table 1. The modeling elements considered in this model and that may be subject to updating proposals through annotations are those shown in Figure 4 marked from A trough F. Depending on the modeling element annotated in each level of detail, the various actors who play different roles in the operational model (which are also represented in figure 4) may play different roles in the PROASIS, as annotator of the model, and reviewers or evaluators of the annotations [56]. Examples of the relationships between these roles at each level of detail considered are depicted in the following subsections of this document.

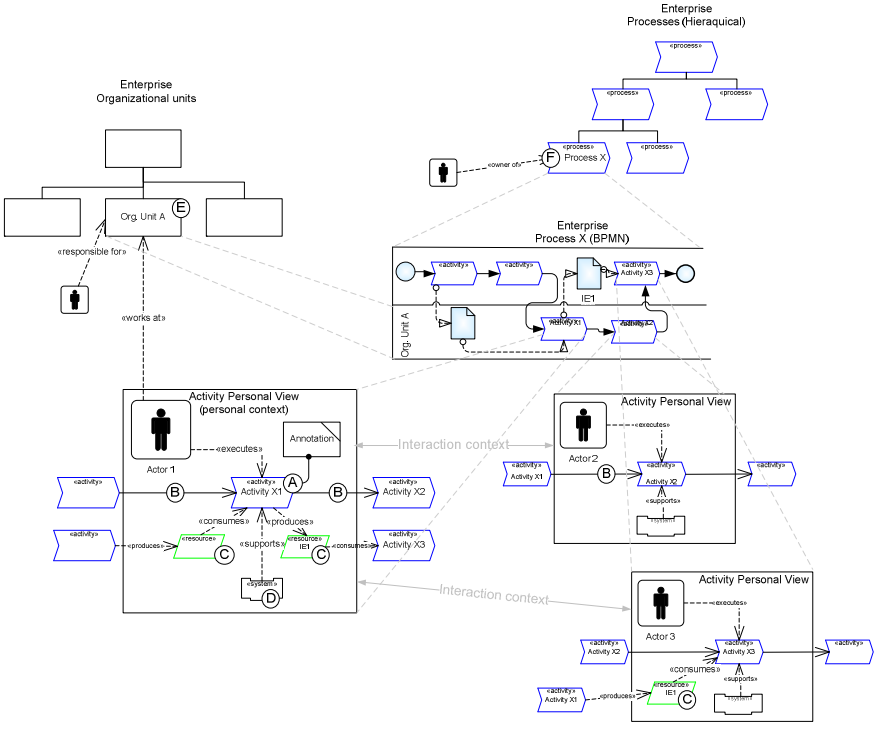

Fig. 4. Operational Model Contexts and Actors [56]

Figure 5 shows the set of modeling elements that can be considered for an actor to make an annotation at the activity level of detail: 1 - Activity; 2 – Workflow; 3 – Informational Entity and 4 – Information System.

An actor can annotate activities and other modeling elements attached to the activities since he is an executer of the activity in the operational model.

The review done at this level of detail involves all the actors who, according to the model, share the modeling element that was annotated. Table 2 shows the actors who are considered reviewers for each annotation type. The reviews are used to express agreement or disagreement with the annotation made.

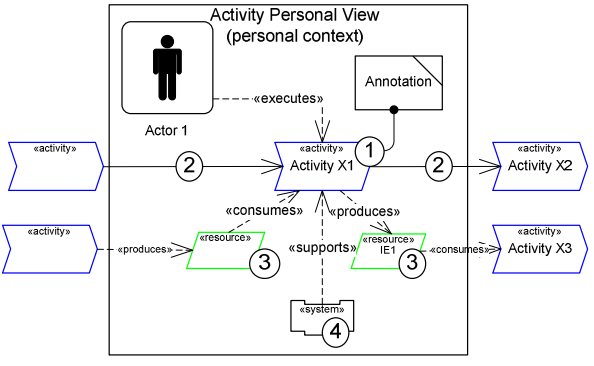

Fig. 5. Personal Activity View (Personal Context)

Table 2. Reviewers and Modeling Elements

Annotated modeling element	**Reviewers**
Activity	Executing actors of an annotated activity
Work Flow	Actors who executes an activity which is the origin or arrival of workflow
Informational Entity	Actors who executes an activity which creates or reads an informational entity
Information System	Actors who executes an activity which is supported by information system

The evaluation of the annotations will be performed by actors who have operational responsibility to the annotated element and hierarchical responsibility before the annotator, so whatever the element annotated at the activity level of detail, the annotation will be evaluated jointly by the owners of the process containing the activity and the heads of organizational units of actors involved. The evaluators may approve or disapprove the annotation. An annotation could be considered as a basis for updating the as-is model by the modeler only if the result of the evaluation of the original annotation will be the joint approval by all the evaluators.

Annotations made by the process owners to any modeling element belonging to the processes that they owns, or by the organizational unit responsible for any activity

executed (or for any modeling element manipulated in the execution of the activities) by the organizational actors that belong to that organizational unit, can be considered optionally. If this option is considered, these actors also belong to the reviewers group.

At Process level of detail, the PROASIS standard annotator is the process owner (figure 6). The process owner can make annotations to the process that he owns as a whole, and this annotation can be reviewed by the organizational units responsible that are responsible for actors who execute the activities that comprise the process.

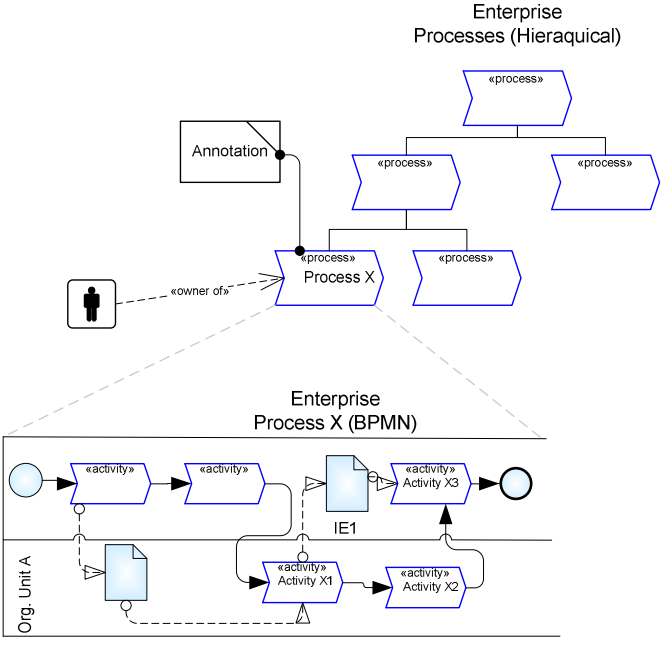

Fig. 6. Process Annotation

The evaluation of the process annotation is made jointly by those involved in its reviewing (process owner and organizational units responsible involved in the process).

Optionally, the frontier process may be considered as modeling elements that can be annotated. In this case the modeling element that will actually be annotated is the workflow that connects the two activities that are on the border between the two processes. If a process owner makes an annotation to a frontier process, the reviewing and evaluation of the annotation will have to involve, in addition to those in charge of organizational units that have responsibilities in both processes, the owners of both processes.

If the model is constructed only up to the process level of detail, only the processes owners, the organizational units responsible and the set of executer are known. It can be assumed that either the process owner or the executors of the activities that

comprise the process can make annotations. The set of executers, the process owner and in addition, the organizational units responsible, can participate in the reviewing of annotations. Consequently, the evaluation is made by the owner of process and/or the organizational units responsible involved. If the original annotation is approved, can lead to a new as-is model version.

At the organizational unit level of detail, the typical annotator of the organizational unit annotated as a whole is the organizational unit responsible (Figure 7).

The review of this kind of annotation involves the organizational unit responsible that originated the annotation and the process owners whose processes have activities performed under the responsibility of the annotated organizational unit.

The Evaluation involves the same actors involved in reviewing the annotations, requiring a joint annotation approval to be considered valid for the modeler in order to update the model, generating a new version of the as-is model.

Optionally, and considering the hierarchical characteristics of organization diagram, which represents organizational units in a tree structure model, the subunits responsible can also be annotators. In this case those responsible can also participate in the annotation review, but cannot participate in the annotation evaluation. Moreover, also the organizational responsible of the higher units can become annotators of the lower level units, but in this case, this also implies the participation in the evaluation.

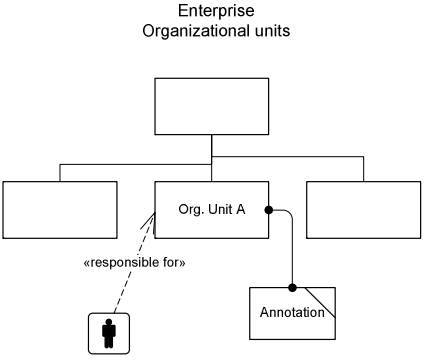

Fig. 7. Organizational Unit Annotation

3.3 Annotation Categories in PROASIS

One of the goals in defining PROASIS was to approach as much as possible its collaborative updating process to the problem domain of business processes modeling. To achieve this, some options were taken.

The annotation stays attached to the annotated modeling elements. Consequently, reviews and evaluations stay attached to the annotation made.

Some categories of annotations were created to restrict the universe of discourse. These categories were derived from the work of Becker-Kornstaedt [31] that recognized that the integration of annotations in the models could be classified as adaptive maintenance (to capture context changes in activity or process execution),

perfective maintenance (to capture better and more information about execution) or corrective maintenance (to capture modeling corrections). Thus the following categories of annotation were created: correction, detail augmentation and adaptation. The annotations can contain, in addition to the category, a textual explanation or diagram made by the annotator, which allows the actors to annotate the model through a draft model diagram containing the proposed corrections. In this case, the universe of discourse is restricted because this diagram must comply with the notational language used for process modeling.

In the review of annotations, the actors should express agreement or disagreement regarding the notation made, complemented with text.

In the evaluation of the annotations, the actors should express approval or disapproval regarding the annotation made, complemented with text.

3.4 Modeling PROASIS with DEMO Methodology

The notion of ontology aims to understand the essence of the construction and operation of an organizational system. The following text expresses the essence of PROASIS:

“The "client" of PROASIS (corresponding role of the operational model that detects misalignment between the model and "reality") wants to update the model, so he makes an annotation (update request). This update request is received by the modeler (which is who actually update the model if the annotation is approved) and by the reviewers. When reviewers receive the annotation, they can begin the review of the annotation (which is optional). The evaluation of the annotation is made based on the analysis of the annotation (update request) and reviews. If the annotation (request update) is approved, the model will be updated and delivered to the "client"”.

In the text above, an independent transaction (T1) is identified, corresponding to the delivery of a final product to the environment, which is in this case, the delivery of an updated enterprise business process model. The production fact of this transaction is the delivery of a particular update of the model. The following transaction result table (table 3) shows the transaction T1 and the dependent transactions T2, T3 and T4.

Table 3. Transaction Result Table of PROASIS

Transaction	**Result**
T1 – Model Update	R1 – The model M is updated
T2 - Annotation	R2 – The Annotation AN is created
T3 – Revision	R3 – The Revision R is made
T4 - Approval	R3 – The Evaluation AV is made

The process structure diagram shows the structure of PROASIS (figure 8): after an actor of the operational model making an update request (annotation), it can be seen that to deal with the promise of T1 (T1/pm) the modeler performs two acts: the coordination act T3/rq (which means that he promises to update the model based on the annotation made only if there is an approval of the evaluator) and the execution act of T1 (which will only be executed if the evaluator approves the annotation). At

the same time, when the actor of the operational processes requires an update to the model (T1/rq), this same actor "transposes" to PROASIS as an annotator, and T1/rq leads to T2/rq, and after executing T2, also leads to T3/rq, since it requires the review of the annotation that he did. The transactions T3 and T4 both imply negotiation processes. The new instance of the model produced in T1, reflects the changes expressed in the annotation, and the set formed by annotation/reviews/approvals became part of it.

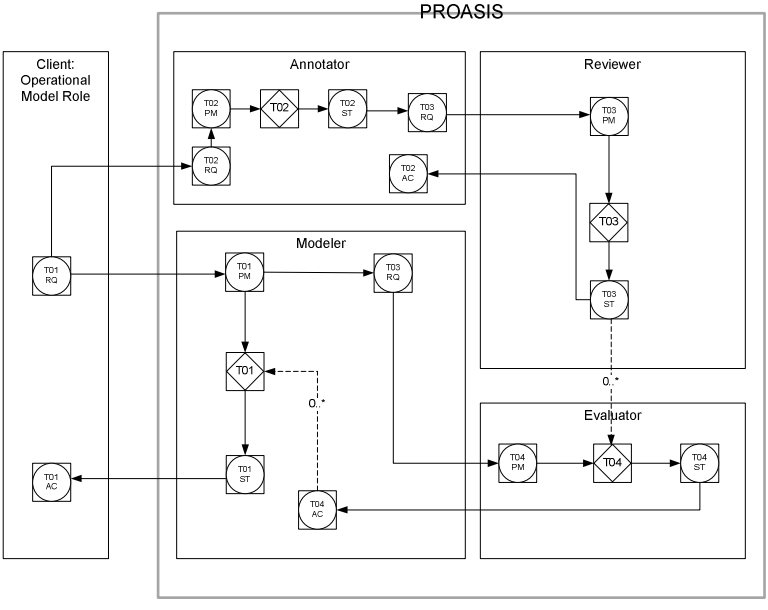

Fig. 8. Process Structure Diagram of PROASIS

Figure 9 shows the association between the two models, the operational (that one that is being updated) and the PROASIS (that one that is used to update the operational model, represented with the DEMO actor transaction diagram), modeled with the Actor Transaction Diagram (ATD) of DEMO. This association is expressed by the dynamic relationship among the roles of each model. The initiation of the transaction T1 (in PROASIS) is made by the operational actor role that makes an annotation, which could by any of the roles defined in the operational model, depending of the annotation context. Consequently, the review and evaluator roles are dynamically assigned because they depend of the associations among the modeling elements of the operational model. PROASIS modeling with DEMO shows and emphasizes: The essential elements of PROASIS, the organizational roles involved (annotator, reviewer, evaluator and modeler) and the transactions of PROASIS (annotation, review, evaluation and modeling), and their relationship with the roles of the operational processes, which act as initiators of the transactions on PROASIS.

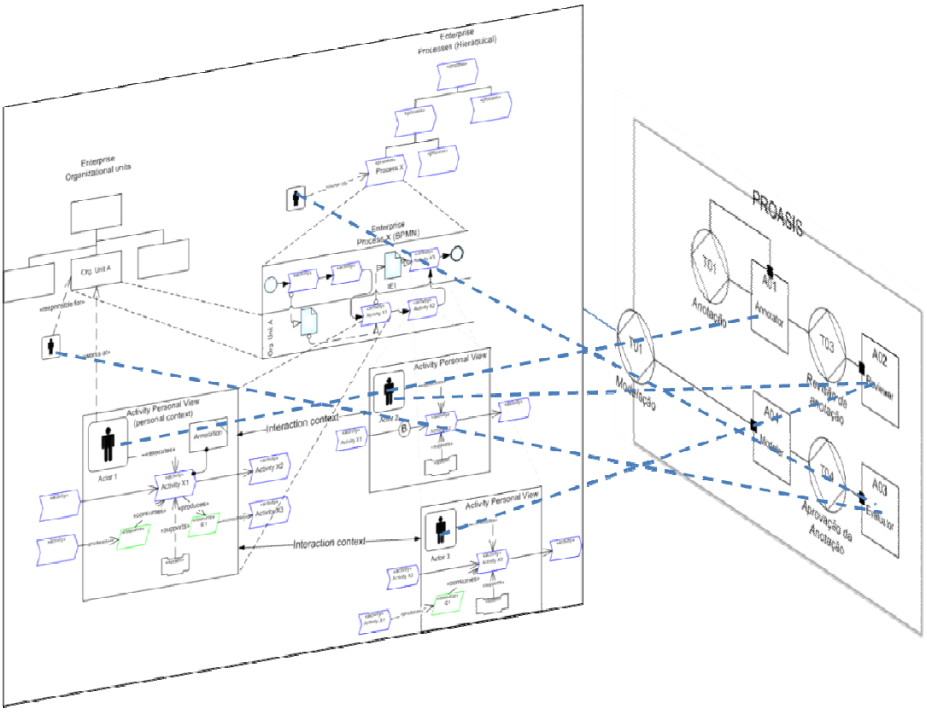

Fig. 9. Relationship between operational model and PROASIS

4 MAPA: PROASIS Supporting Tool

The PROASIS supporting prototype tool, named MAPA (Monitoring and Annotation of Processes and Activities), was defined and developed as a groupware Web based tool that allows the dynamic update of the business process models in a collaborative way, with the following general requirements:

- Annotation editing functions: actors need support to make immediate annotations in the context where the experience occurs. Therefore, an annotation creation, modification and deleting system must be created to be used by organizational actors.
- Different levels of granularity: it should be possible to annotate any object (process, activity, role, resource, relation) in the process model as well as any attribute of each object.
- Selective distribution of diagrams and modeling elements: users only access information that concerns to them, depending on the role played (executor, process owner and organizational unit responsible).
- Access rights: to protect the authors of the annotations, different levels of access rights should be addressed. Only the author of an annotation must be able to delete or modify it.
- Ability to save the entire history of models and their annotations, and the corresponding reviews and evaluations.

- Mapping annotations to entities: is essential to know to what object corresponds each annotation.
- Notification mechanisms: to warn organizational actors about the need to participate in the reviewing and/or evaluation of annotation made and to warn about changes made to the diagrams due to the approved annotations.
- Diagramming capabilities: to allow annotator actors to make graphical annotations with proposed changes to models or to allow modeler actors to directly change the diagrams if the proposals for changing the model was approved.

In developing this platform two versions were created (v1 and v2). MAPA v1 works at the activity detail level. In this version the diagrams are static, so they have to be modeled in a separate tool and then uploaded to MAPA database. Version 2 has emerged as an evolution of version 1. The major implemented change is the direct editing of diagrams. This feature allowed to deploy graphical annotations and to transform the organizational actors in modelers (in this version, any organizational actor can be an active modeler if he plays the modeler role in PROASIS).

This version was designed to operate at the process level of detail, since this was the level to be used in most of the organizations where the MAPA tool was tested. However, the MAPA v2, though not fully implement the activity detail level, allows the annotation of activities and other modeling elements that exists in the process model, either individually or grouped.

The interaction in MAPA v2 allows the direct diagrams handling, so it presents a palette of BPMN modeling artifacts. The interaction at this level can be carried out by annotators who propose changes to the diagrams, and either by the modelers which change the diagrams, updating them. Figure 10 shows the screenshot of the MAPA v2 tool. On this screen, in the left is the process navigation area, in the upper central area is the toolbar (which varies depending on the user's role) and in the center is the drawing area (where the diagrams are presented, and can be changed using the palette of the BPMN modeling artifacts presented in the left of the drawing area).

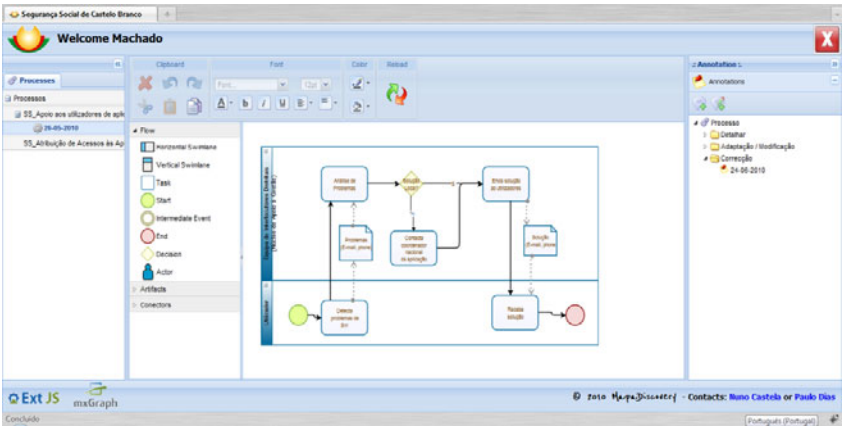

Fig. 10. MAPA v2 screenshot

The interaction with several end users of the case studies organizations provided information to refine the initial requirements of the tool, which lead to the incorporation of new features: incorporation of BPMN specific elements (event types, activity types, etc.); improved diagram visualization in order to allow the comparison of the update proposal diagram (graphic annotation) with the current diagram; improvement of notifications sent by e-mail, indicating the actor who did the action, the annotated process, the annotation/revision/evaluation type and a direct link to the tool (Web site); introduction and improvement of administration functionalities (creation of processes, users, user groups, roles, etc.); introduction of options that enhance the interaction, such as the ability to record a diagram without sending a notification and without generation of history, which allows the incremental recording of diagrams, only sending notification when the diagram is complete.

5 Case Study

The PROASIS and MAPA tool were implemented in several different real organizations in order to test the applicability of the defined process and supporting tool. In this section the case study developed in Social Security Center of Castelo Branco is described.

The Social Security Center of Castelo Branco District (SSCCB) is part of the Social Security Institute. The district centers are the basic organizational and administrative basis of Portuguese Social Security System, responsible for implementing the necessary steps for the development, implementation and management of the benefits under the Social Security System. The organizational goals are timely payment of benefits, combating social exclusion and fraud and supporting workers, families, children, elderly and companies.

In this context and under a perspective of documentation, distribution and analysis of the organizational business processes, it was decided to begin the process of obtaining the information necessary for business process modeling in three organizational units: (1) Financial Management, (2) Administration and Assets and (3) District Interlocutors.

The initial SSCCB business process model was constructed from information gathered from organizational actors, using a methodology that combines the bottom-up and top-down approaches, involving organizational operational actors, who will then use the MAPA tool to maintain the as-is model updated over time.

From the information collected, the organization chart and macro processes hierarchical diagram were built. Both diagrams keep the association of each organizational actor to the organizational units where they work and to the business processes that have activities they execute.

There are currently 19 processes modeled in the tool, belonging to the three organizational units. The activities of these 19 processes are executed by a total of 12 organizational actors. Two of them are responsible of the organizational units.

Figure 16 presents as an example, one of the diagrams that were distributed to capture updates through the annotations, in this context. This figure shows the process “Application Users Support”.

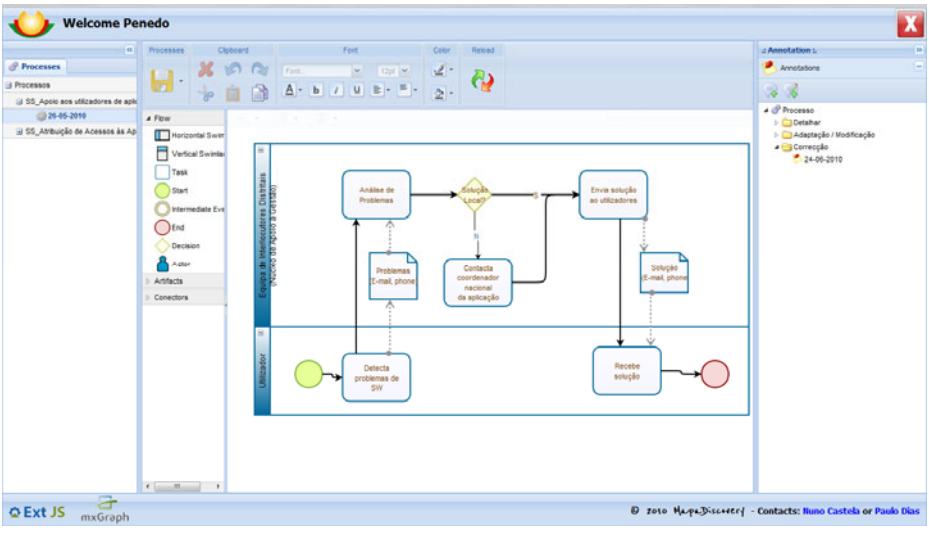

Fig. 11. Process "Application Users Support"

In following figures, a sequence of annotation, review, evaluation and update of the business process diagram "Applications Users Support" is showed. The original version published in the MAPA tool that the actors who belong to this business process (3 executers and 1 process owner) had access, is that one showed in figure 11. In this context, a graphical annotation was made by the organizational actor Proença (figure 12), who have categorized the annotation as a correction and added the following textual description: "This Annotation corrects some flows and create some activities related to EasyVista (support for the resolution of incidents of applications), and turns the notification mechanisms provided by EasyVista visible (including notifications by e-mail)". Figure 13 show the new model diagram proposed in this graphical annotation made directly in the tool based on the diagram published and distributed by MAPA tool.

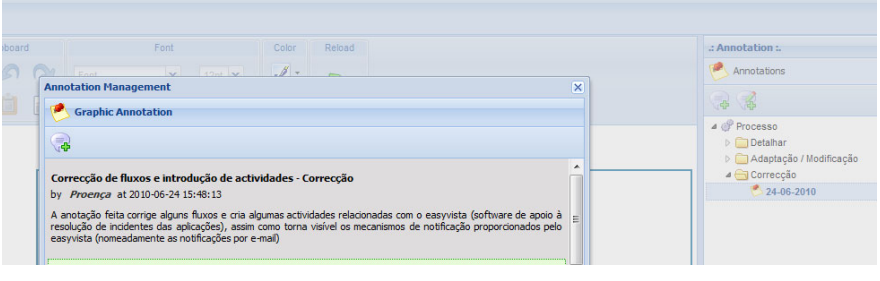

Fig. 12. Annotation made to process "Application User Support"

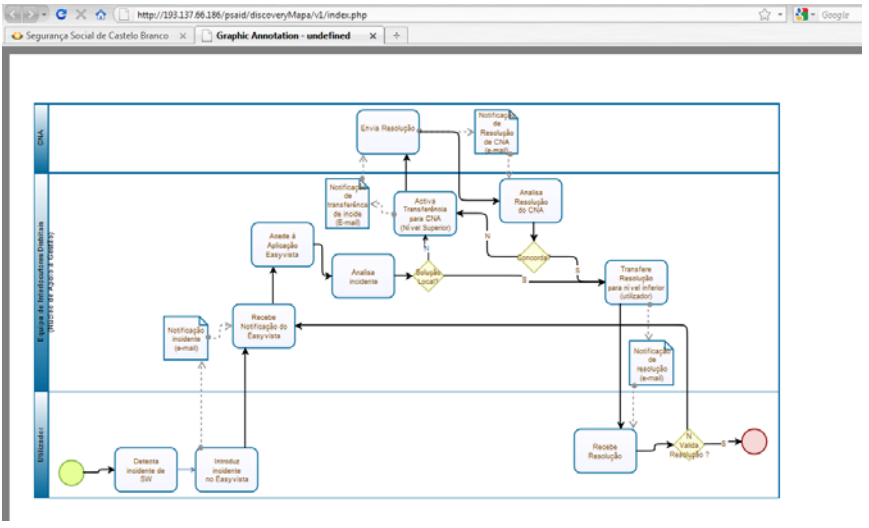

Fig. 13. Alternative model proposed in the scope of annotation made

In figure 14, the reviewing and later evaluation of the annotation described in figures 12 and 13 is made. The annotation had a review made by the organizational actor Domingos, who categorized his review as an agreement and added the following textual description: "I agree, but I think that would be clear if the possibility of the CNA to transfer the problem solving to the II, because we can see, in EasyVista, the state that, in many cases, is in analysis in the II". In figure 14, also can be seen the evaluation made by the organizational actor Penedo, who have approved the annotation and said "The analysis is correct". This approval, together with the other approvals of the annotations made to this version of the diagram shown in figure 11, resulted in a new version of the business process diagram that is shown in figure 15. Note that the full history of the previous version is saved and can be accessed by selecting the process navigator from the left side of the screen.

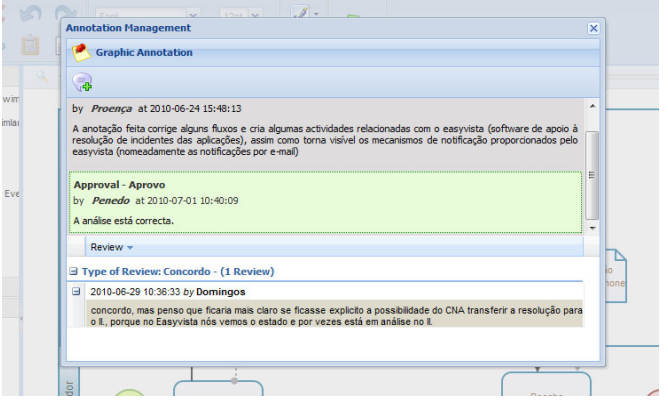

Fig. 14. Reviewing and approval of the annotation made

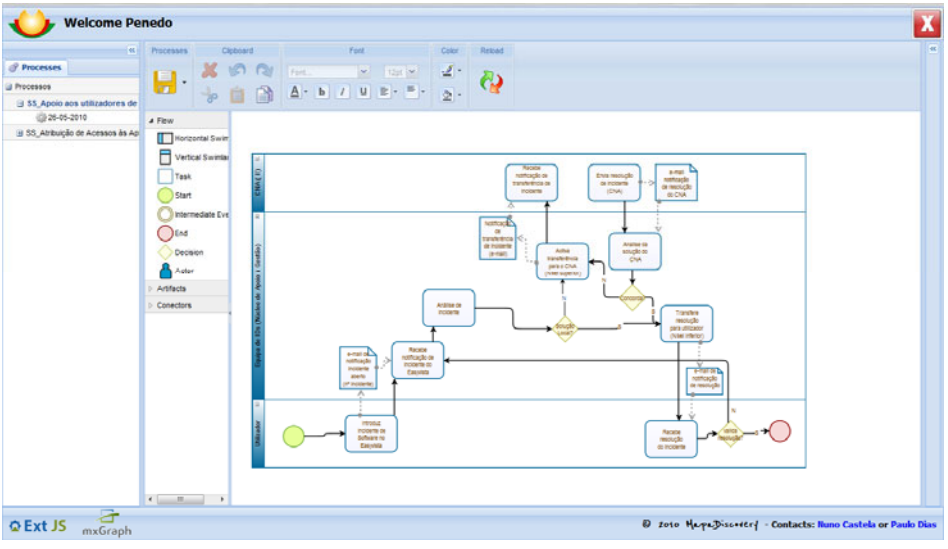

Fig. 15. New Diagram Version of process "Application User Support"

In this case study, which is still ongoing, the first updating cycle with PROASIS using MAPA have started with a total of 19 processes, from which 13 were annotated with a total of 26 annotations (from which 13 were textual annotations and 13 were graphical annotations). There were 37 annotations reviews (from which only one was a no agreement, all others were agreement). The total of annotations evaluated is now in number of 21 (what means that 5 annotations continue with the discussion open). The total number of new versions of the diagrams created due to the notes is 10, meaning that nine of the cases have not yet closed the first cycle of Annotation-review-evaluation-modeling, which culminates with a new version of the diagram initially distributed.

This case study using MAPA to test PROASIS in real organizational environment, has reached its goal: encourage people to discuss their work using a common representation. Also managed to involve the organizational units responsible and processes owners through the approval or rejection of proposals in order to update the model.

There was a great ease in the recognition of the process models within the MAPA tool mainly because the executers and leaders were involved in the initial modeling process. This conclusion drawn from the SSCCB case study is relevant when compared with the initial findings of the Huf Portuguesa case study (a multinational automotive manufacturing company), where the operation of the MAPA tool was initially tried with business processes modeled within the Department of Information Systems, revealing to prove fruitless due to the non recognition of processes by their executors and leaders. In the SSCCB case study, the organizational actors were involved in the modeling process, which began by a bottom-up approach through collecting the individual actions of organizational actors, which validated the abstraction made to define the activities, which in turn were grouped into business processes defined by the organizational responsible by a top-down approach.

The organizational actors showed easiness in interacting with the tool and a great acceptance in using graphical annotations instead of textual annotations. This acceptance is related to the bottom-up methodology used to build the business process model, which directly involved the executers through the gathering of actions, from which the activities were abstracted.

The possibility to assign the modeler role to the process owner provided a considerable improvement in updating processes. This would obviate the possibility of misunderstanding among the purposes of the evaluators and better understanding of what has to be translated to diagram from the evaluations, because both roles could be played by the same organizational actor.

This case study allow, through the cooperation with the users of MAPA v2, to refine some features of the tool and fix some bugs that are normally detected with intensive use.

The interest showed by the national leaders of the SSCCB can be attested trough the decision to extend the case study to all of the district centers of Portugal.

6 Conclusions and Future Work

The tool to support the business process model updating process is currently being used, beyond the case study presented in this paper, in two universities, in a multinational automotive manufacturing company and in a theatre company.

With the available results it is considered that the organizational actors annotated corrections and updates to the model that are usually related to the validation of the diagrams produced, yet allowing the actors directly involved (executers, process owners and heads of organizational units) in the validation (and subsequently update) of the model to try to align it with the reality in an interactive and shared way. By the facts observed in case studies, the annotations, and its extensions (reviews and evaluations) satisfy the requirement of being appropriate mechanisms to support the conversation between the actors and their representation.

The DEMO methodology has revealed appropriated to model the essential meta-process defined in this work and to easily demonstrate what is the dynamics of PROASIS role assignment to actors executing the operational processes in organizations. It was found that the dynamic assignment of roles depends on the context in which the annotation is done at the operational level. This characteristic distinguishes this work from a simple construction of a process and tool to collaboratively update something.

The introduction of MAPA tool in real organizations revealed that it may have an important role, not only in gathering the information needed to update the model (beyond the first important role in validating the model constructed initially), but also because it allowed the opening of a communication channel that encourages the collection and sharing of knowledge about organizational activities. MAPA also demonstrate that actors can play an active modeler role in a collaborative and distributed way.

PROASIS is important in the growth of individual self awareness, because provide explicit representations to the organizational actors that are left with a better sense of what they do and the surrounding context. It was also important to increase the self

awareness of the groups around processes and activities. The organizational self awareness gained from the contribution and explanation of group and individual knowledge through the creation of the historical evolution of the business processes (versions of the process diagrams), which contains all the annotations history (and its negotiation/discussion) that culminated, at certain moments in time, with the proper evolution of the modeled processes, aligning them with their implementation in practice.

Future work, in operational terms, will focus on consolidation of the case studies presented and the refining of PROASIS and MAPA tool.

The refining of PROASIS will focus on better defining the annotations categories, in order to find annotations patterns to improve the update statement made by organizational actors.

MAPA tool prototype will be further developed. The main aim is to provide it with a number of features that enhance the frequency of use by organizational actors. This can be done including links to real artifacts that are required during the execution of processes and activities. This objective will provide access to quality manuals in context (e.g. the work instructions of activities can be accessed), access to user manuals for the computer systems needed to support each activity and access to the documents templates needed in the processes.

References

1. Tribolet, J., Winter, R., Caetano, A.: Editorial Message: Special Track on Organizational Engineering. In: ACM Symposium on Applied Computing, Santa Fe, New Mexico (2005)
2. Schekkerman, J.: How to Survive in the Jungle of Enterprise Architectures Frameworks, 3rd edn. Trafford Publishing, Canada (2006)
3. Caetano, A., Silva, A., Tribolet, J.: Object-Oriented Business Process Modeling with Roles. In: 7th International Conference on Information Systems Implementation Modeling (ISIM 2004), Czech Republic (2004)
4. Bernus, P.: Enterprise models for enterprise architecture and ISO9000:2000. Annual Reviews in Control 27, 211–220 (2003)
5. Davenport, T.H.: Process Innovation: Reengineering Work Through Information Technology. Harvard Business School Press, Boston (1993)
6. Hammer, M., Champy, J.: Reengineering the Corporation: A Manifesto for Business Revolution. HarperBusiness, New York (1993)
7. Vinturella, J.: Management Briefing Business Process Management (BPM): Must Have? (2005), `http://management-briefings.jbv.com` (published in April 30, 2005)
8. Goul, M., Corral, K.: Enterprise model management and next generation decision support. Decision Support Systems 43, 915–932 (2007)
9. Kim, H.M., Fox, M.S.: Using Enterprise Reference Models for Automated ISO 9000 Compliance Evaluation. In: Proceedings of the 35th Hawaii International Conference on System Sciences (2002)
10. Chapurlat, V.B., Kamsu-Foguema, F.: Prunet: Enterprise model verification and validation: an approach. Annual Reviews in Control 27, 185–197 (2003)
11. Sousa, P., Caetano, A., Vasconcelos, A., Pereira, A., Tribolet, J.: Entreprise Architecture Modeling with Unified Modeling Language. IRM Press (2005)

12. Loucopoulos, P., Kavakli, E.: Enterprise Modelling and the Teleological Approach to Requirements Engineering. International Journal of Intelligent and Cooperative Information Systems (1995)
13. Boudreau, M.-C., Robey, D.: Coping with contradictions in business process re-engineering. Information Technology & People 9(4), 40–57 (1996)
14. Magalhães, R.: Fundamentos da Gestão do Conhecimento Organizacional, Edições Sílabo (2005)
15. Magalhães, R., Tribolet, J.: Engenharia Organizacional: das partes ao todo e do todo às partes na dialéctica entre pessoas e sistemas. In: Costa, S.G., Medeiros, L., Vieira, Rodrigues, J.N. (eds.) Capítulo do livro "Ventos de Mudança", Fundo de Cultura, Brasil (2007)
16. Tribolet, J.: Organizações, Pessoas, Processos e Conhecimento: Da Reificação do Ser Humano como Componente do Conhecimento à "Consciência de Si" Organizacional. In: Amaral, L. (ed.) Sistemas de Informação Organizacionais, Edições Sílabo (2005)
17. Zacarias, M., Pinto, H.S., Magalhães, R., Tribolet, J.: A 'context-aware' and agent-centric perspective for the alignment between individuals and organizations. Information Systems 35(3), 271–374 (2010) (in press)
18. Weick, K.E.: Sensemaking in Organizations. Sage Publications, Thousand Oaks (1995)
19. Zacarias, M., Magalhães, R., Caetano, A., Pinto, H.S., Tribolet, J.: Towards organizational self-awareness: An initial architecture and ontology. In: Rittgen, P. (ed.) Ontologies for Business Interactions, pp. 101–121. IDEA Group, USA (2008)
20. Zacarias, M.: Conceptual Framework based on Agents and Contexts for the Alignment between Individuals and Organizations. Dissertação para obtenção do grau de doutor em engenharia informática e de computadores. IST, Lisbon (2008)
21. EMIPA-SIG: A state-of-the-art analysis by the Special Interest Group (SIG) on Enterprise Modeling: Issues, Problems, and Approaches. In: International Conference on Enterprise Integration Modeling Technology (ICEIMT), South Carolina (June 6-10, 1992)
22. Castela, N., Tribolet, J: Representação As-Is em Engenharia Organizacional. In: 5ª CAPSI, Lisboa, Portugal (Novembro 3-5, 2004)
23. Lankhorst, M.: Enterprise Architecture at Work: Modelling, Communication and Analysis. Spinger, Germany (2005)
24. Zachman, J.: A framework for information system architecture. IBM Systems Journal 26(3), 84–92 (1987)
25. Whitman, L., Ramachandran, K., Ketkar, V.: A Taxonomy of a Living Model of the Enterprise. In: Proceedings of the 2001 Winter Simulation Conference (2001)
26. Fox, M.S., Gruninger, M.: Enterprise Modeling. AI Magazine, 109–121 (Fall 1998)
27. Giaglis, G., Paul, R., Serrano, A.: Reconciliation of Business and systems Modelling Via Discrete Event Simulation. In: Proceedings of the ACM's 1999 Winter Simulation Conferences (1999)
28. Nonaka, I., Takeuchi, H.: The Knowledge-Creating Company. Oxford University Press, Oxford (1995)
29. Smith, M.K.: Chris Argyris: theories of action, double-loop learning and organizational learning. The encyclopedia of informal education (2005), http://www.infed.org/thinkers/argyris.htm (last update: January 28, 2005)
30. Matos, M.: Organizational Engeneering, an overview of current perspectives, Dissertação para obtenção de grau de Mestre em Engenharia Informática e de Computadores (2007)
31. Becker-Kornstaedt, U., Reinert, R.: A Concept to Support Process Model Maintenance through Systematic Experience Capture. In: SEKE 2002, Ischia, Italy (July 15-19, 2002)
32. White, S.: Introduction to bpmn. Technical report, IBM Corporation (2004)

33. Dietz, J.L.G., Habing, N.: A Meta Ontology for Organizations. In: OTM Workshops 2004, pp 533–543 (2004)
34. Dietz, J.L.G., Hoogervorst, J.A.P.: Enterprise Ontology and Enterprise Architecture - how to let them evolve into effective complementary notions. GEAO Journal of Enterprise Architecture 2(1) (March 2007)
35. Dietz, J.L.G.: Enterprise Ontology: Theory and Methodology. Springer, Heidelberg (2006)
36. Dietz, J.L.G.: The atoms, molecules and fibers of organizations. Data Knowl. Eng. 47(3), 301–325 (2003)
37. Hatch, M.J., Cunliffe, A.L.: Organization Theory, 2nd edn. Oxford University Press, Oxford (2006)
38. Magalhães, R.: Organizational Knowledge and Technology. Edward, Elgar Publishing, Aldershot (2004)
39. Bohm, D.: Wholeness and the Implicate Order. Routledge, London (1980)
40. Axelrod, R., Cohen, M.D.: Harnessing Complexity. Basic Books, New York (2000)
41. Giddens, A.: The Constitution of Society. University of California Press, Berkeley (1984)
42. Engeström, Y., Miettinen, R., Punamäki, R.: Perspectives on Activity Theory. Cambridge University Press, Cambridge (2005)
43. Heylighen, F.: Self-Organization, Emergence and the Architecture of Complexity. In: Proceedings of the 1st European Conference on System Science, pp. 23–32. AFCET, Paris (1989)
44. Finlayson, J.G.: Habermas. Oxford University Press, Oxford (2005)
45. Stein, L.: Genome annotation: from sequence to biology. Nat. Rev. Genet. 2, 493–503 (2001)
46. Flanagan, D.: Java in a Nutshell. O'Reilly, Sebastopol (2005)
47. Unified Modeling Language Specification, Version 1.4.2, formal/05-04-01 (also available as ISO/IEC 19501) (2005)
48. Oinas-Kukkonen, H.: Towards evaluating knowledge management through the 7C Model. In: Proceedings of the European Conference on Information Technology Evaluation, (ECITE 2005), Turku, Finland (September 29-30, 2005)
49. Yang, S.J.H., Chen, I.Y.L., Shao, N.W.Y.: Ontology Enabled Annotation and Knowledge Management for Collaborative Learning in Virtual Learning Community. Educational Technology & Society 7(4), 70–81 (2004)
50. Marshall, C.C.: Toward an ecology of hypertext annotation. In: Proceedings of ACM Hypertext 1998, Pittsburgh, PA, pp. 40–49 (1998)
51. Borghoff, U., Schlichter, J.: Computer-supported Cooperative Work: Introduction to distributed Applications. Springer, Germany (2000)
52. Gonzalez, P.P., Framinan, J.M.: Tools For Collaborative Business Process Modelling, Business Information Systems: Concepts, Methodologies, Tools and Applications, vol. 4, pp. 636–648. Information Resources Management Association, USA (2010)
53. Ellis, C.A., Gibbs, S.J., Rein, G.L.: Groupware: Some Issues and Experiences. Communications of the ACM 34(1) (1991)
54. Rittgen, P.: Negotiation Models. In: Krogstie, J., Opdahl, A.L., Sindre, G. (eds.) CAiSE 2007 and WES 2007. LNCS, vol. 4495, pp. 561–573. Springer, Heidelberg (2007)
55. Gazendam, H.W.M., Liu, K.: The evolution of organisational semiotics: A brief review of the contribution of Ronald Stamper. In: Filipe, J., Liu, K. (eds.) Studies in organisational semiotics. Kluwer Academic Publishers, Dordrecht (2005)
56. Castela, N., Zacarias, M., Tribolet, J.: Business Process Model Dynamic Updating, Communications in Computer and Information Science (CCIS). In: Proceedings of the International Conference, CENTERIS 2010, Viana do Castelo, Portugal, vol. 110 Part (2), pp. 158–167. Springer, Heidelberg (2010)