Discovering Business Processes from Work Practices

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Abstract. Business process modeling methodologies need to pay attention to (1) the changing and distributed nature of business process, and (2) the contextual and tacit nature of the knowledge that operational actors have regarding business process. However, available methodologies offer little guidance to these. This paper describes how to model business process models from work practices, using the BAM methodology. BAM is a methodology for business process modeling, supervision and improvement that works at two dimensions; the dimension of processes and the dimension of work practices. The paper illustrates BAM's business process discovery approach with a case study in a real organizational setting.

Key words: business process modeling, work practice modeling

1 Introduction

Business process modeling (BPM) specializes on describing how activities interact and relate with each other, as well as their relationship with other business concepts such as goals and resources, where resources may be informational entities and human or automated actors. Business Process Modeling (BPM) methodologies are supported by data collection techniques including interviews, surveys, text/document analysis, among others. However, it is argued that existing BPM methodologies are not appropriate to elicit the distributed and frequently tacit knowledge that is required in building business process models. Moreover, little guidance is offered in terms of maintaining up-to-date representations of changing processes. Process-centric approaches tend to emphasize process (workflow, decision, information, activities) as the dominant dimension [1]. Nonetheless, an activity-agent-product centric approach should also capture interactions between of activities and people, products, information and other resources that contribute to the execution of activities. Another limitation of BPM methodologies stems from the tacit nature of knowledge. Indeed, most organizations simply do not know their end-to-end processes accurately or in detail, since their process knowledge is tacit and decentralized [4]. Recent research in BPM is aiming to address the unpredictability of business processes [2, 3], but other concerns remain to be addressed.

Work practice is a concept that originates in socio-technical systems, business anthropology, work systems design and management science [5]. Work practices

are the behaviors expressed as action patterns of *specific* individuals, performing *specific* activities, in *specific* circumstances. Work practices involve people engaging in activities over time, not only with each other, but also with machines, tools, documents, and other artifacts. The importance of discovering work practices to improve user support has been acknowledged in [6, 7]. Work practice modelling is also important to (1) address concerns disregarded by BPM such as providing a deeper understanding of the human activities composing business processes, and (2) assessing the alignment between process models and actual execution [8].

This paper describes and illustrates the Business Alignment Methodology (BAM). BAM is aimed at modeling and improving business process models from work practices. This approach is driven first, by the idea that organizations need to model and improve business process descriptions, through a collaborative approach involving not only business analysts and process owners, but also all operational actors. Second, the dynamic nature of organizations and their environments results in frequently changing work practices affecting the pace of change in business processes. Third, BAM acknowledges the frequently tacit nature of the knowledge that operational use in executing business process knowledge.

The remainder of this paper is organized as follows; section 2 summarizes related work on business process modeling, work practice modeling and context modeling. Section 3 summarizes BAM methodology. Section 4 illustrates the first phase of the proposed methodology with a case study in a real organizational setting. Section 5 outlines our conclusions and outlook.

2 Related Work

2.1 Business Process Modeling

Several BPM frameworks propose describe the ways of building business process representations. Some of these descriptions are systematic and detailed methodologies encompassing a set of procedures, techniques and tools to support the acquisition process. BPM methodological frameworks are composed of several steps and include descriptions of the inputs and outputs of each step [9, 10, 11]. These frameworks are mostly manual and involve several human resources. Automated support is typically restricted to support the depiction of graphical representations. Data collection techniques involve combinations of techniques drawn from the field of qualitative research, and include focused interviews, workshops and surveys. In some cases, templates to support data collection are also provided. These templates facilitate the recording of the model components (e.g. list of human and automated actors) and the relationship between them (e.g. actors of a given activity).

The semiotic-based approach developed by Dietz [12] provides a language-action perspective (LAP) methodology that guide the construction of business

process models. Data sources are textual descriptions of the enterprise operation (no specific collection techniques are provided). Dietz conceptualizes operations at 3 levels; (1) performa (data), (2) informa (information) and (3) forma (transactions). Once collected, the descriptions are analyzed using two techniques (*performa-informa-forma* and *coordination-actors-production analysis*) that perform a semantic analysis of these descriptions. In the former, sentences corresponding to the *performa, informa* and *forma* levels are distinguished with different colors. The latter uses different types of brackets to distinguish `actors`, `coordination acts` and `production acts`.

2.2 Work Practice Modelling

Research efforts in work practice modelling aim at supporting system development. Pomerol and Brezillon developed a context model and representation language [13], and applied their approach in modelling the operational practices of the Paris subway control line [14]. A premise of this work is that the main distinction between operational practices is the *context* where these practice apply. Their model of context relates the notion of context and knowledge. Context surrounds a focus (e.g. a particular step of a task at hand). For a given focus, context is the sum of three types of knowledge; external knowledge, contextual knowledge and proceduralised context. *External context* represents knowledge that is related but not relevant for a particular problem step. *Contextual knowledge* is the corpus of knowledge directly relevant for a problem step. *Proceduralised context* is the part of contextual knowledge that is invoked, assembled, organised, structured and situated according the given focus and shared among the actors involved in the decision involved. The authors represent proceduralised contexts through contextual graphs. Contextual graphs are oriented and without circuits. They are composed by two essential concepts; (1) actions and (2) contextual nodes. Actions are elementary acts composing a task. Contextual nodes are conditions surrounding task execution that may alter the course of actions taken (e.g. location, motivation, user or time-related factors).

Sierhuis [7] propose an activity-based multi-agent modelling environment to model work practices. The authors develop a notion of situatedness supported by the following concepts; (1) people and knowledge, (2) situated action, (3) situated cognition, (4) situated learning and (5) autopoiesis. As a result, the representation language BRAHMS (Business Redesign Agent-based Holistic Modelling System) was developed to model knowledge in situated actions and learning in human activities. The most central representation unit in Brahms is called a `workframe`, a situation-action rule consisting o *pre-conditions*, `actions`, *detectables* (noticed *facts* of the world, with what probability and when during the actions), and *consequences*. Workframes are organised hierarchically into *activities*. Actions in a workframe may be primitive or composite (another activity). Primitive actions may also include movement to another location and communication. Consequences and actions are ordered and interleaved. Detectables may be indicated as "impasses" that interrupt the workframe or as "end conditions" that end the workframe or its encompassing activity.

Brahms models what agents do during the day, not just tasks. The language consists of groups of agents with context-sensitive, interactive behaviours. It combines the perspective of *business process models* and the perspective of *cognitive process models* and it is designed to make social processes visible by incorporating what people know of each other, relevant to assigning jobs, getting assistance and prioritizing work. Thus, Brahms models how work get done, emphasizing practices, while incorporating standard task flow views and productivity statistics.

These approaches regard the particularities of the agents performing activities and situations. Nonetheless, they were developed for systems development purposes. Consequently, the set of concepts provided require specialised skills and are thus too complex for the non-technical personnel typically involved in organisational analysis. Their linkage to other enterprise views is also not fully explored.

A further aspect not addressed in detail are the corresponding model building methods. Pomerol and Brezillon research focus more on work practice representation than the methods to capture it. Whereas the Brahms language is complemented with a systematic method to build the model, little detail is provided about how to *capture work practice*. Lundberg and Berquist [15] specifically focus this issue and describe a combined ethnographical approach, labelled by the authors as "eclectic ethnography", to capture work practice for systems design.

2.3 Context notions and modelling approaches

Work practice research shows the relevance of the notion of context. Nevertheless, despite several efforts to achieve a shared understanding around this notion, [16], the definition of context remains dependent on its application area. The AI field has developed an extensive research on context. In a pioneer work, McCarthy [17] introduces contexts as abstract mathematical entities to allow axioms valid within limited contexts to be expanded to transcend its original limitations. He argues that the formulas ist(c,p) (i.e., a proposition p is. true (ist) in a given context c) are always considered as them-selves asserted within a context, i.e. we have something like ist(c',ist(c,p)). Hence, this regress is infinite.

In computer sciences, context is viewed as a collection of things (sentences, propositions, assumptions, properties, procedures, rules, facts, concepts, constraints, sen-tences, etc) associated to some specific situation (environment, domain, task, agents, interactions, conversations, etc). In problem solving, Pomerol and Brézillon define context as the implicit constrains of each step of a problem. The notion of context developed by these authors is used in modeling problem solving practices at work.

In cognitive sciences, B. Kokinov [18] developed a dynamic theory of context that defines it as the set of all entities that influence human (or system's) behaviour on a particular occasion. The main principles of the dynamic theory of context are: (1) context is a state of the mind, (2) context has no clear-cut boundaries, (3) context consists of all associatively relevant elements and (4) context is dynamic.

Sociological approaches typically regard context as networks of entities (people, actors/agents and artifacts), that emerge from the interactions among them. Whereas some focus on the network elements, others focus on its emergent properties. In the latter case, context is regarded as sets of rules and resources that support and define interactions patterns among agents [19]. Activity Theory [20] and Actor-Network Theory [21] have been used in modelling social contexts

3 Business Alignment Methodology (BAM)

BAM methodology (see figure 1) represents a multidisciplinary approach that allow business analysts to improve business processes discovery, monitoring and analysis, paying attention not only to process but to product, information and human dimensions through actual work practices. Although business processes do involve different actor perceptions, aligning processes and work practices is essential in order to adjust business processes in response to changes in the organization, and reaching a global view of the actual organization. The methodology proposes a two-dimensional approach, encompassing three phases : (1) Business Process Discovery, (2) Business Process Supervision and (3) Business Process Assessment and Improvement. Business Process Discovery provides an initial process specification through interviews and collaborative methods. Business Process Supervision assures that daily practices follow base business process models. Business Process Assessment and Improvement allows to analyze performance measures to improve and refine business process models. Since the goal of this paper is to illustrate results from the Business Process Discovery phase and due to space limitations, this phase will be described in more detail than the remaining phases.

Each phase integrates two dimensions; (1) Process and (2) Practice. The Practice dimension explores day-to-day work based on individual and group actions and practices. This dimension captures and represents in various ways onsite information needed to systematically validate business process models. This dimension entails addressing the knowledge that operational actors (represented by individuals or groups), have of their own actions. In the practice dimension, knowledge is local and frequently tacit, thus it is hard to formalize. The Practice dimension covers information needed to systematically support or reject many process decisions based on the result of daily experiences.

In the Process dimension, business analysts discover, review and improve business process descriptions, based on information of the Practice dimension. The process dimension addresses knowledge that crosses functional divisions and organizational boundaries (clients, suppliers). Therefore, organizational processes embody specific accumulated knowledge that is not confined to particular individuals or groups. This knowledge, which is explicit, needs to be transmitted and shared among the individuals and groups working at the functional divisions responsible for executing the corresponding business process. The process dimension also addresses the need of continuous business process supervision

and improvement as a reaction to fast-changing environments in the business world.

These two dimensions, Practice and Process, will ensure the proper structure to articulate individual, group and organizational knowledge with the knowledge of business analysts. The BAM methodology was designed for explicitly addressing the social dynamics of business process specification. It is based on social interactions as proposed in a two-dimensional space.

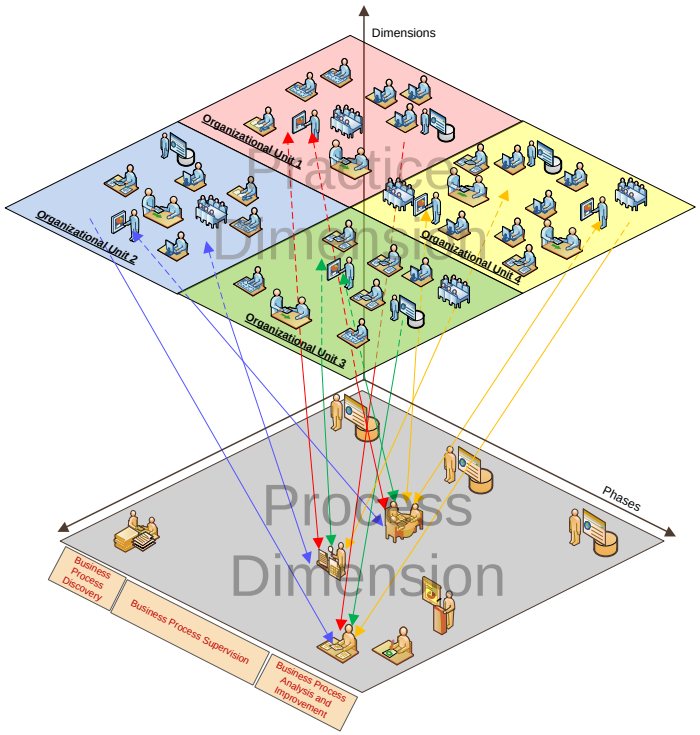

Fig. 1. BAM overview

3.1 Business Process Discovery

The main goal of a Business Process Discovery (BPD) is to get personal descriptions of business processes from work practice descriptions. BPD phase aims at developing an organizational profile of people, activities, technology, and information in order to capture actual business processes. This phase includes two main sub-phases: (1) Learning (Eliciting) Business (LB) and (2) Modeling Business (MB).

Learning Business The Learning Business phase encompasses three activities; (1) kickoff meeting, (2) eliciting information of practice and process, and (3) elaborating preliminary practice and process descriptions. The kickoff meeting communicates operational actors the goal and procedures of the BPD phase. Information elicitation is accomplished according to the nature of each dimension. The outcome of this subphase are preliminary descriptions of both work practices and business processes.

Practice Dimension In our framework, work practices are defined in terms of action patterns, that is, recurrent action sequences. Due to its local nature, work practices vary according the context of execution. Moreover, operational actors are often unaware of their recurrent action patterns. Hence, instead of conducting standard interviews and workshops, the approach to elicit work practices is accomplished as follows: (1) Capturing daily actions, (2) Identifying action and interaction contexts created by related actions, and (3) discovering recurrent action patterns within contexts.

Capturing daily actions creates action repositories, where each action is registered as <actor, action, resource> triples. Actions refer to fined-grained operations of actors' daily work. Actions are identified with verbs taken from the vocabulary shared among operational actors. Resources may involve information, tools, materials or even human knowledge not yet externalized in external sources. Resources are described with nouns or nominal phrases using actors' own vocabulary. Actions may be communicative or not communicative. Communicative actions involves two actors; a sender and a receiver.

Understanding the meaning of actions requires situating them in a particular context. Drawing from the sociological notion, **action contexts** are defined as situations created by action streams performed by one or more operational actors. Action streams performed by a single individual create **personal action contexts**. Interaction streams i.e. communicative actions exchanged between two or more actors that are part of a single conversation, create **interaction contexts**. Under this definition, action and interaction contexts are uncovered by grouping sequences of actions related to a given situation. Once identified, contexts are analyzed in order to discover recurrent action patterns within them. It is noteworthy that action and interaction contexts and patterns are not generic. Rather they refer to specific persons, places a time periods.

Process Dimension The action patterns discovered at the practice dimension are then analyzed and discussed by operational actors and business analysts in order to define business processes, as well as the business activities and resources, composing business processes. This discussion entails an aggregation process that is accomplished in a bottom-up fashion. However, a top-down application of high-level knowledge of the organization such as organizational goals and strategies is required in driving the definition of business process. The dynamic interplay between these two dimensions (practice and process dimensions) shows the synergy between key operational actors and activities described by business analysts involved in BPD.

Learning phase roles The Learning Business phase involves two roles; (1) operational actors are responsible for registering daily actions and identifying action and interaction contexts and (2) business analysts who are responsible for conducting the kickoff meeting, discovering action patterns, and associating them to business activities, roles, and resources.

Modeling Business The subphase Modeling Business, involves several stakeholders (business analyst, process owner, organizational unit responsible and operational actors) that perform three interrelated activities (1) model construction; (2) model revision and evaluation and negotiation and (3) model approval. These activities support a negotiation process that if successful, results in a shared view of the process. Finally, the model approval activity concludes the interaction process and collaboration among the parties involved in a business process model specification by approving or rejecting the model. The techniques used in model construction vary according the dimension.

Practice Dimension The action and patterns identified within particular contexts in the previous phase are shared, discussed among operational actors and business analysts involved in similar activities in order to identify which practices yield better results.

Process Dimension The process representation concerns activities, resources, decision points and work flows (topology). In the Process dimension, business analysts use the best practices that lead to business process reviews and improvement. Action patterns represent alternative proposals that result from the execution of different individuals and groups who may act based on different assumptions and meanings. Business analyst then define business process models based on previously identified best practices. .

Modeling phase roles The Modeling Business subphase involves four roles; (1) operational actors are responsible for assessing their practices and identifying best practices, (2) organizational unit responsible is in charge of modeling work practices (3) business analysts who are responsible for helping operational actors in identifying best practices, and helping the organizational unit responsible in modeling work practices and (4) process owners are responsible for building process models based on best practices.

3.2 Business Process Supervision

In the Business Process Supervision (BPS) phase, formal control mechanisms are designed in order to ensure that operational actors carried out real business activities as described by business models. Control mechanisms consist of two main activities: (1) compare work practices with base business process models, and (2) identify new business process model descriptions. The outcome of this phase are revised versions of base business process models.

The milestone that marks the end of this phase and the beginning of the Business Assessment and Improvement phase is crossed when business analysts

and operational actors agree that: business process model describe the detailed behavior that address real needs, major problems have been solved, business process practices provides some useful value to the organization and these practices are stable enough to implement a new and improved business process version.

3.3 Business Process Assessment and Improvement

In this phase, the business analyst analyze change proposals and through a comparison between base business process models and proposed changes, a new set of models is build to correct work that is not proceeding well, by showing where adjustments need to be made. In the end, the results gathered during assessments enable improvements and consistent refinements in order to produce an improved set of business process models. This phase ends when all the involved actors agree that: the objectives set during BPD (and modified throughout the second phase) have been met; and especially if all participants are satisfied with the new business process model version

4 Case Study

4.1 Organizational setting

The Business Process Discovery phase of the methodology was tested a software development team of 4 programmers and the project leader, who performs both programming and project management tasks. The team develops web applications for a commercial bank.Team members perform systems analysis, design, programming, test and maintenance activities. During the observation period, the team worked on the following applications; (1) Suppliers, (2) Claims, (3) Client correspondence management (called Mail application), (4) Evictions and (5) Marketing Campaigns. Being a key user and a small case, the team manager worked also as the business analyst. The team manager's chief played the process owner role.

4.2 Business Process Discovery Results

The research goal and data collection methods were discussed in a briefing session. Worksheets with templates to registered actions were distributed. In order to achieve some standardization regarding the terms used, the meeting also served to discuss typical action names and resources.

Learning phase - Practice dimension A set of 534 actions was manually collected through a three-week observation period. Figure 2 shows an extract of an action log that illustrates the structure defined for actions. Due to human multitasking, grouping actions in personal contexts is essential to distinguish related from unrelated actions. This discrimination use achieve with the notion of personal contexts. Personal contexts are discovered by grouping together action sequences

nº	day	Actor/Sender	Receiver(s)	action type	description	tools	documents| information	human
1	6	Carla	team members	propose	a team meeting at 15h	e-mail	team member addresses	
2	6	Pproduction area	Mariana, Catarina	inform	error in automatic table updates	e-mail	error message	
3	6	Carla	Catarina	command	find a solution to the automatic table update problem	e-mail	Catarina' address	
4	6	Carla	CG team	propose	test claims application (integration tests)	telephone	CG team tlf. number	
5	6	CG team	Mariana	accept	test claims application (integration tests)			
6	6	Carla		prepare	prepare claims application test environment	claims application	test data	claims application knowledge (testing procedure)

Fig. 2. Some registered actions

performed by a given individual and belonging to a given situation or topic. Such groupings allow defining context features such as frequent action types and resources, and labeling each context. Figure 3 depicts the context features of the personal contexts of the participant subject Carla, labeled as "Development Support". Figure 4 shows the personal contexts identified for Carla and Alexandre, two participants of our case study.

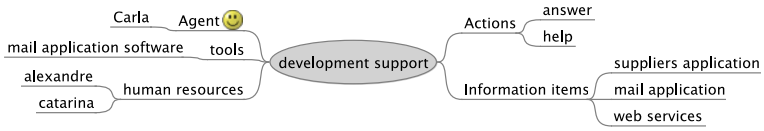

Fig. 3. Carla's personal context "Development Support"

Person_Name	Context_ID	Context_Description
alexandre	a1	Data Collection for Mail Application
alexandre	a2	Mail Application Programming
alexandre	a3	Evictions Web Service Problem
alexandre	a4	Team Meetings
carla	c1	Common Services Application Programming
carla	c2	Programming support
carla	c3	Team Meetings

Fig. 4. List of Personal Contexts

Nonetheless, to properly understand execution, it is not enough to model personal contexts and individual behaviors. Most tasks are executed by several individuals. Hence, it is necessary to identify and characterize interaction contexts. The analysis of interaction contexts allows to see which resources are shared (and how) between different individuals.

Day	Nº	Ag-Sender	Contex	Ag-Receiver	Action	Emb. Action	Description Item Keywords
9	111	alexandre	a3	mariana	request	publication	quality environment
9	111	alexandre	a3	mariana	request	publication	updated evictions web service
9	115	mariana	m6	alexandre	request	test	quality environment
17	315	alexandre	a3	mariana	request	publication	evictions web service
17	315	alexandre	a3	mariana	request	publication	quality environment
17	318	mariana	m6	alexandre	inform	publication	evictions web service
17	318	mariana	m6	alexandre	inform	publication	quality environment
22	393	mariana	m6	alexandre	request	discuss	evictions web service
22	402	alexandre	a3	mariana	inform	NULL	evictions web service

Fig. 5. Evictions Web Service Action Stream

Whereas personal contexts are identified from action streams of a single individual, the identification of interaction contexts is made from action streams from *two* or more given individuals. Interpersonal contexts relate two specific personal contexts of interacting individuals. Figure 5 depicts an action stream created by a problem detected on the "evictions web service". This action stream involves several interactions between Alexandre's personal action context `a3`, and Mariana's personal action context `m6`.

Identifying interaction contexts allows uncovering actual action patterns used in executing activities. Hence, allows assessing how these patterns differ among different groups and from pre-defined business process models. Following the proposed approach, this identification is situated within given interaction contexts, and their associated personal contexts.

Interaction Context	Personal Contexts	Description
ic1	$< a1 - x >$	data collection for mail application
ic2	$< a1 - m011 >$	cards information collection
ic3	$< a3 - m6 >$	evictions web service problem
ic4	$< c2 - a5 >$	web services and mail app. support
ic5	$< c2 - m8 >$	suppliers app. support
ic6	$< g2 - t3 >$	suppliers app. support

Table 1. Some interaction contexts

Table 2 depicts the action patterns identified within the action repository of this case study. With the data collected, in this case it was possible to identify recurrent action sequences composed of two to six action types. Actions in italic represent actions that do not appear within all sequences but that were inferred, based on the fact that they need to be executed in order for the remaining actions to take place.

Learning subphase - Process dimension Action patterns uncovered at the Practice Dimension can be used in a bottom-up fashion to discover actual business activities, processes, and resources. However, in this case, the organization had previously accomplished a business process modeling initiative, having already identified a list of pre-defined activities composing business processes. Hence,

ID	Context Name	Action Pattern
ic5	suppliers application support	1.request (help) - 2.help
ic6	suppliers application support	1.ask - 2.answer
ic7	suppliers application support	1.request (help) - 2.help
		1.request (solve) - 2.solve
ic8	team meetings	1.propose - 2.accept - 3.assist
ic9	project management reports	1.request (update) - 2.update-3.send
ic11	integration tests	1.request (test) - 2.test
		1. inform(test results) - 2. test
ic16	software publication	1.request (publication) - 2.perform (publication)
		3.test - 4.inform (publication)
		5.inform (publication)-*6.inform(publication)*

Table 2. Some action patterns

in this case, action patterns were associated to those activities. Due to space limitations, the list below shows only the pre-defined activities related to the action patterns depicted in table 2

1. Test application components (ic11)
2. Publish application components (ic16)
3. Support users (ic5, ic6, ic7)
4. Ellaborate project reports (ic9)
5. Monitor Project Progress (ic8)

Action repositories include descriptions of the information items, tools, materials or knowledge used or produced by each action. However, at the process dimension those items need to be linked with formally defined resources already associated to given business activities or processes. In this case, a list of such resources was pre-defined together with business activities. The table depicted in figure 6 shows the relationships between most frequently found items and activity resources.

Description Item	*Freq. Formal Resource*
team meeting	52 projects
quality environment	33 application status
suppliers application	32 suppliers application
suppliers application web component	28 suppliers application
mail application	28 mail application
suppliers application data management class	24 suppliers application
common services application	23 common services application
suppliers application application class	22 suppliers application

Fig. 6. Associating action resources to activity resources

Modeling subphase - Practice dimension As aforementioned, the action patterns found in specific contexts allows uncovering action patterns of specific individu-

als or groups. For example, figure 7 depicts a publication practice of some team members. This practice was uncovered from the action pattern found in interaction context ic16. Notice how practices are specific to particular persons and tools used by them. It is also noteworthy that a practice maybe related to more than one formally defined activity. The publication practice includes actions belonging to two pre-defined business activities; (1) test and (2) publish software components.

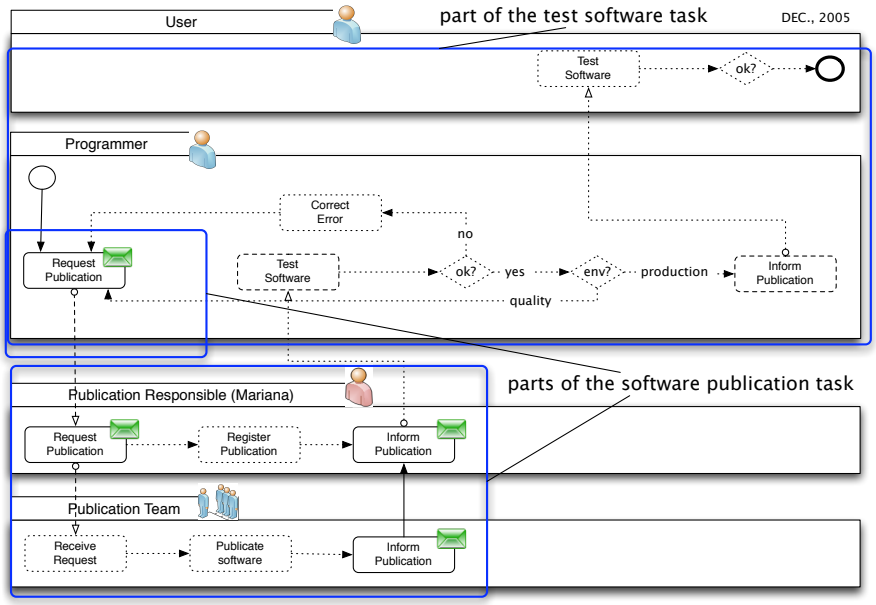

Fig. 7. Publication practice

Modeling subphase - Process Dimension After collecting diagrams representing several practices, the team gathered to discuss which would be considered the best practices. Best practices were then used to build a software development process to be shared by all teams. Figure 7 depicts a process model resulting from this phase. The figure shows the process that resulted from putting together the best practices related to software development, or from redefining current practices. The resources shown in the figure were uncovered as illustrated in figure 6.

5 Conclusions

This paper illustrates an application of the BAM methodology. Driven by the distributed and dynamic nature of business processes, BAM's design is struc-

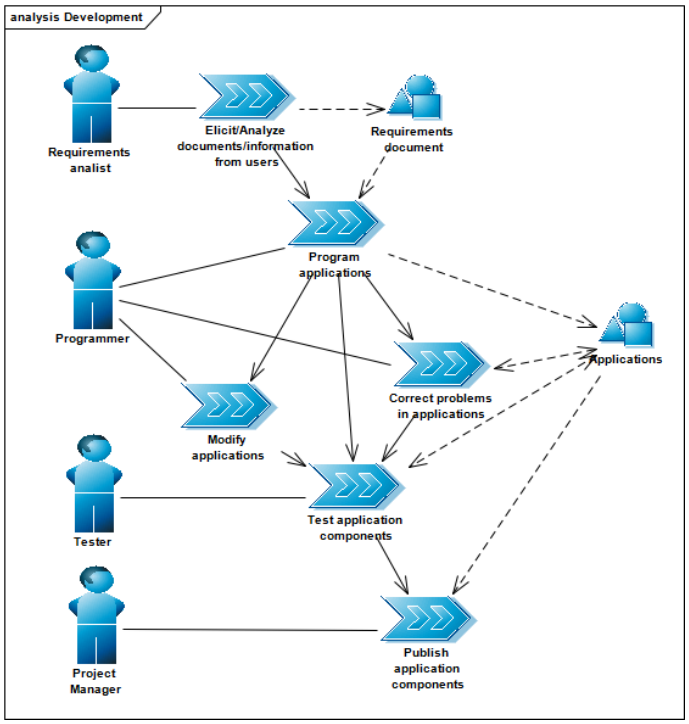

Fig. 8. Generic Software Development Process

tured in three phases and two dimensions. This paper illustrates the Business Discovery phase for the Practice and Process dimensions, through a case study conducted in a real organizational setting. An informal evaluation of the case study results with all participants indicated that operational actors felt at ease working with concepts of the Practice dimension, and quickly echieved agreements when discussing about work practices. Both the team manager that acted as a business analyst and the supervisor that acted as the process owner indicated that having work practice descriptions was helpful in discovering business processes.

The paper offers a partial illustration of the methodology. More extensive case studies encompassing the whole methodology with more formal evaluation techniques are required in order to have a more comprehensive evaluation of BAM. An exploration and development of automated methods for data collection and analysis is also essential in order to enable larger and longer case studies.

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