Improving Workflow Project Quality Via Business Process Patterns Based on Organizational Structure Aspects

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Abstract: The correct definition of business process is a key to achieve quality in workflow project. Accordingly, this paper proposes business (sub)process candidate patterns to be used in business process modelling. The candidate patterns differ from other proposals first because they focus on task flow descriptions and second because they are based on organizational structural aspects. Our proposal is to store the patterns in the catalogue of the Transactional Metamodel of Business Process introduced in this paper. The metamodel makes feasible the modelling of business process through the use of business subprocess patterns based on organizational structural aspects. An additionally feature of the metamodel supports the generation of business subprocess patterns through the Business Process Execution Language for Web Services (BPEL4WS).

1 Introduction

Organizations reach their business objectives by executing their business process. A business process can be understood as a partial order of tasks, where each tasks contributes in a stage of the process. In this context a business subprocess is a process integrated to as well as controlled by another business process.

Business process has an important role in how organizations are structured. Mostly researchers and professionals agree that first the business process must be defined and after this the organization must be shaped to best operate it [DW96]. Accordingly, to shape an organization involves at least two steps. In the first step business processes executed in the organization are identified. In the second step, concerning the business processes, specific values are assigned to a set of structural aspects[1].

[1] Structural aspects are per example the centralization of decision-making, the coordinate mechanisms and the scalar chain. The set of structural aspects differs one kind of organization to another (e.g., matrix, functional and linear).

Modern organizations have performance demands related at least to both the execution time and resource consumption of their business process. Within this context, the workflow technology has shown to be very effective, mainly in business process automation.

A business process model offers domain level concepts and enables a broader distribution of knowledge among other business-related people with different skills and knowledge of an organization [Ju03]. A business process is automated through a workflow process. Based on a workflow metamodel a workflow process groups all elements required for the business process automation. These elements comprise not only dynamic aspects (tasks and transitions) but also static aspects (data, application and participants). Hence, a workflow process model can contain aspects not represented in the corresponding business process model [Fr04].

This paper proposes a new approach for business process modelling. The key concept of the approach is business process candidate patterns based on organizational structure aspects. Each pattern characterizes a relation between one or more organizational structure aspects of an organization and corresponding business process executed on it. Per example, the structure of a document approval process may vary depending on the level of centralization of decision-making (less or more) in high positions (e.g. manager, president) of the organization. The use of this class of patterns in business process modelling may improve the workflow project accuracy hence the workflow process will better represents the real business process as it is executed in the organization.

In the remainder of Section 1 we address the problem that motivates our research as well as corresponding proposal to solve the problem. Furthermore, we survey related work. Section 2 describes the Governmental Organization where the business subprocess candidate patterns, proposed in this paper, were discovered. In section 3 examples of candidate patterns are presented. Section 4 describes a Transactional Metamodel of Business Process (TMBP). In Section 5 we propose a methodology describing how TMBP can be used in business (sub)process modelling. Finally, section 6 gives an outlook to future developments and research directions.

1.1 Problem Statement

Recently, Business Process Modelling and Workflow Process Modelling became subject of various specifications and standardization efforts [MSN04]. Different consortia including the Business Process Management Initiative (BPMI) as well as the Workflow Management Coalition (WfMC), the World Wide Web Consortium (W3C) and the Organization for the Advancement of Structured Information Standards (OASIS) have proposed metamodels for business process modelling and workflow process modelling. However, these metamodels present some limitations:

- their submodels for organizational structure aspects representation show limited power of expression. Most of them just consider the use of organizational structure aspects in the assignment of task execution performer.

- the use of business process patterns based on organizational structure aspects is not considered in business process modelling. Accordingly, the reuse advantages of patterns are not applied in the workflow project modelling phase. Therefore not only performance but also quality of whole workflow project may not be guaranteed. Nevertheless, the workflow process may not represent the real business process as it is executed in the organization, hence the organizational structure aspects are limited related with business process modelling.

1.2 The Proposal

This paper proposes:

- Candidate patterns for business (sub)process modelling based on organizational structure aspects[2]. We call candidate pattern because we agree with the pattern community consensus that a pattern can be established after it is identified in at least 3 real cases. Our approach considers only one workflow application, although this application was implemented through a (large) set of workflow process. Accordingly, we need two more workflow applications to prove our candidate patterns. Nevertheless, we understand a business (sub)process pattern as a set (one or more) of recurring tasks that can be reused in specific situations concerning related organizational structure aspects. We are looking forward to store the patterns in the patterns catalogue of TMBP.

- Aiming implementation issues we also propose TMBP methodology. The methodology comprises tree steps: (1) creation of business process models through TMBP; (2) automatic generation of BPEL4WS[3] processes corresponding to the business process models and; (3) execution of BPEL4WS process via workflow engine.

We opted for BPEL4WS in favor of other languages (e.g., the Business Process Modelling Language (BPML) [Ar02] and the Web Service Flow Language (WSFL 1.0), first because of the reuse properties of BPEL4WS and second because of the existence of powerful development of tools and other technologies that greatly increase the level of automation and thereby lower the cost in establishing cross-enterprise automated business process. Moreover, BPEL4WS advantages are recognized by UML community, providing, mappings from UML to BPEL4WS [Ga03], [LR04].

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[2] We developed a case study where we identified dependency relationships between one or more organizational structure aspects and its more than 60 workflows sub-processes. Each relationship gave rise for a candidate of business (sub)process pattern. [TI03]

[3] Business Process Execution Language for Web Services.

1.3 Related Works

Patterns capture existing, well-proven experience in software development and help to promote good design practice [BUS96]. However, patterns for business process and workflow process modelling are still subject of discussion and research. This section reviews some of existent work in this context.

Wil van der Aalst proposed 21 workflow patterns for the description of business process behaviour [Aa00], [Aa03]. Each pattern represents a routing construction (e.g., sequential, parallel and conditional) to be used in workflow process modelling. More recently, the author proposed a set of workflow data patterns aiming to capture the various ways in which data is represented and utilized in workflows [SHE04]. However, patterns are connected with organizational structure aspects.

Workflow patterns were also proposed in the context of WIDE[4] project. WIDE approach for modelling phase of a workflow system is mainly based on the use of a pattern catalogue, which can be reused in several projects [GPS03]. The patterns proposal of WIDE is also not based on organizational structure aspects.

Last but not least, SAP[5] created a cross-application tool called SAP Business Workflow. The tool makes feasible the integration of business tasks between applications [An03]. It also includes a workflow wizard with workflow templates (e.g., approval procedures) [SPH03]. However, these templates are only slightly linked with organizational aspects.

2 Governmental Organization Profile

This section provides an overview of the governmental organization used as scenario to discover the candidate patterns proposed in this paper. The main activities accomplished in the organization refer to the Environmental Licensing Process[6]. Follow sections present core organizational structure aspects of the governmental organization.

2.1 Scalar Chain

The scalar chain specifies who is subordinated to whom in organizations [Ch00]. It is defined based on the organizational chart[7]. Accordingly, the governmental organization scalar chain is defined through four positions[8]: the president, the director, the division manager and the department manager (as shown in Figure 1).

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[4] Workflow on Intelligent Distributed database Environment Model.
[5] Anwendungen und Produkte in der Datenverarbeitung in der Datenverarbeitung.
[6] The environmental licensing process involves administrative tasks such as preparation and approval of official documents, inherent to the issue of a certain environmental license.
[7] The organizational chart describes the organizational structure by its organizational units (e.g., departments, divisions and staffs) and their respective relationships [Ju04]
[8] A position is an elementary description of the responsibilities of an employee [Ju04].

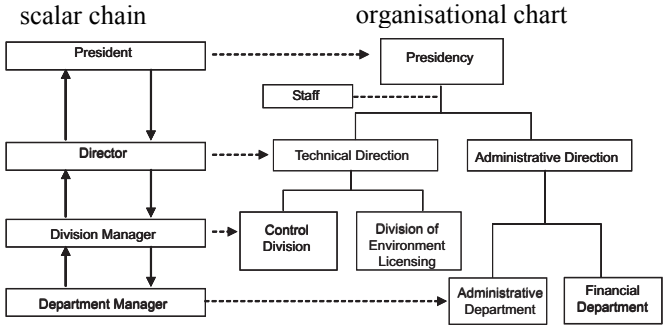

Figure 1 – Scalar chain and organizational chart of the governmental organization

2.2 Decision-Making Structure

Authority to decision-making in organizations can be less or more centralized. In the first case, individuals at the top of the organizational chart has the highest authority to make decisions and authority of other individuals is delegated, top-down, according to their position in the organizational chart [JON01]. In the governmental organization authority to decision-making is high centralized in positions at the top of its organizational chart.

2.3 Coordination Mechanisms

In our approach to coordinate means to manage dependencies between tasks and between requirements needed for task execution. Coordination mechanisms can be classified in mutual adjustment, direct supervision, standardization of work processes, standardization of results and standardization of skills [Mi95]. In the governmental organization we identified not only direct supervision[9] but also standardization of skills[10].

3 Candidate Patterns for Business (Sub)process Modelling

Due to space limitation the technique used to identify the business process candidate patterns is not described in this paper. Information about it is in [TI03]. Through the technique, at about 5 candidate patterns were identified. The candidate patterns can be considered complementary, hence they should be extended as Subsection 4.5 proposes. Next Subsections bring two examples of candidate patterns described through Buschmann notation [Bu96] and illustrated via activity with actions diagram of UML 2.0 [Om03]. Figures 3 and 4 must be, respectively interpreted according with Legend Figure 2 brings.

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[9] A position coordinates the work executed by another positions (subordinate), guiding and monitoring them.
[10] Predefined abilities (e.g., know how to program in Java) the task performer needs to have.

3.1 Candidate Pattern for Question Answering

The question answering process concerns the identification of specific skills needed for a task execution performer. Depending on the skills a particular organizational role and corresponding actor is assigned for both task execution and question answer.

Name: Question Answering

Context: During a task execution, questions concerning its execution can emerge. Hence, is desirable to have task performers with appropriate skills and knowledge to execute it. Accordingly, the question answer pattern includes two parameters: a task and a question.

Problem: Questions can emerge during the execution of a specific task.

Solution: the question answering candidate pattern is recommend in these both situations: (1) a question answering process needs to be modelled; (2) specific skills are required for the task performer. Figure 3 illustrates the candidate pattern.

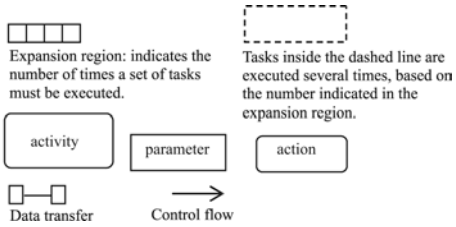

Figure 2: Legend

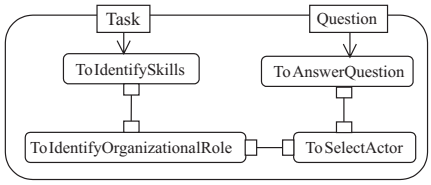

Figure 3: Candidate patterns for question answering

As shown in Figure 3, not only desirable skills needed for task execution are identified but also corresponding organizational role. Based on the organizational role the best actor is assigned for task execution.

3.2 Candidate Pattern for Document Approval

The document approval process is a sequence of agreements. Each agreement is performed by one organizational role. The process ends when all organizational roles conclude their evaluations or one of then does not agree with the document content.

Name: Document Approval

Context: In this paper to approve means to make a decision about something that needs to be evaluated. Accordingly, the approval process includes at least two parameters: an item (e.g., document) and an organizational role responsible for decision task.

Problem: The structure of the document approval process may vary depending on the level of decision-making i.e., less or more centralized.

Solution: The document approval candidate pattern is recommend when these two situations are identified: (1) an approval process must be modelled and; (2) the process is executed in a context with high centralization of decision-making and direct supervision of work. Figure 4 illustrates the candidate pattern.

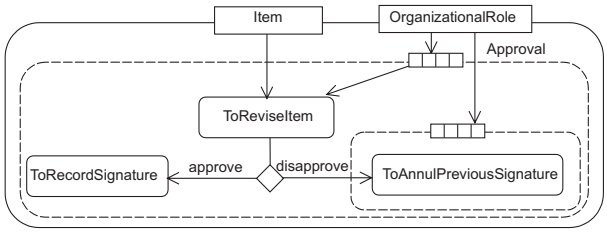

Figure 4: Candidate Pattern for Document Approval

In Figure 4 an organizational role performs a document review (item). In case it agrees with the document content its signature (proving his approval) is recorded. In case it disagrees, all previous signatures (in case they exist) are annulled and the process should end. The actions inside the dashed line are repeated in the number of organizational roles given by input parameter or some disapproval occurs.

4 Introduction to TMBP

TMBP is an extension of the Transactional Model of Workflow Processes developed in the context of WIDE project. Nevertheless, the metamodel is a package composed of five subpackages (see Figure 5). While `PBusinessProcess` package depends on the `POrganizational`, `PResource` and `PRouting` packages, `PCatalogue` package depends on `POrganizational` and `PBusinesProcess` packages.

The metamodel is described through Unified Modelling Language (UML) notation [FS00]. We opted for UML because it provides a wide range of modelling resources, such as class diagram, use case diagram and activities with actions diagram required to represent all TMBP singularities.

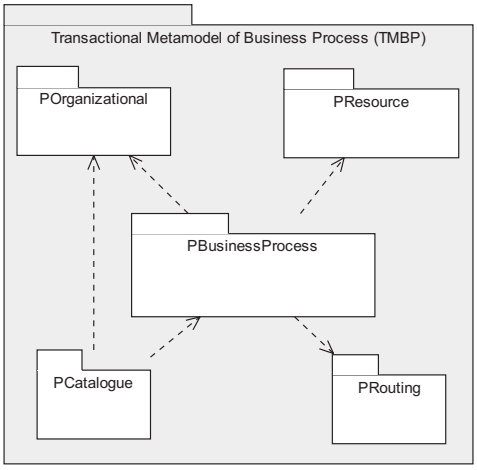

Figure 5: Transactional metamodel of business process

4.1 Organizational Package

Roles (as shown Figure 6) can be differentiated between functional[11] and organizational roles[12] [NS02]. An organizational role is associated with actor[13] and with organizational unit (e.g., department, division). Nevertheless, it is a generalization of functional role. A functional role is associated with skill (e.g., to know how to program in Java) and competence (e.g., may sign orders > than $ 20.000).

An organization is an aggregate of organizational units. Each organizational unit may be related with other organizational units. The relationship not only helps in organizational chart definition but also expresses multi-dimensional organizations (e.g., matrix-structures) [Mü99].

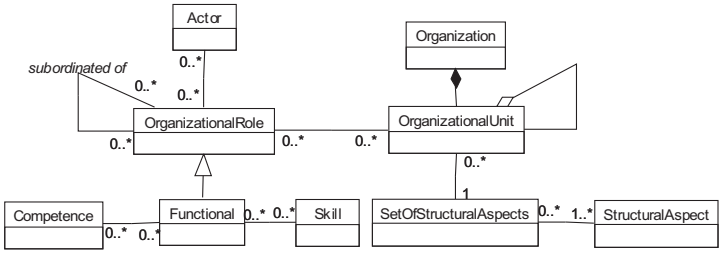

Figure 6 – Organizational package

4.2 Routing Package

Routing along particular branches determines which task needs to be performed and in which order [AH02]. We apply Wil van der Aalst workflow patterns in TMBP routing package [Aa00] (see Figure 7). Due to space limitation we present a simplified class diagram just to illustrate the routing patterns we are considering. A detailed explanation based on the solution of [Wh04] can be found in [Th04].

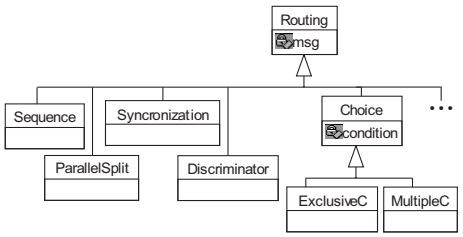

Figure 7: Routing package

[11] E.g., to formulate rules; to review and approve documents.
[12] E.g., manager, director, president.
[13] An actor is the responsible for a task execution.

4.3 Resource Package

A resource defines artifacts needed for the execution of a task [Ju03]. The Resource package (as show Figure 8) distinguishes two kinds of resources: a tool (e.g., word processor, printer) and an item ─ instance of `ItemType` (e.g., official document, chair's back). Depending on the kind of item, it may have a structure (class `ProductStructure` in Figure 8).

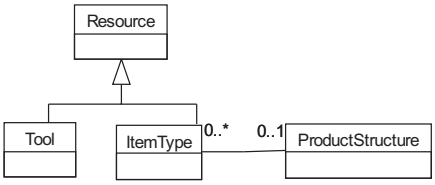

Figure 8 – Resource package

4.4 Business Process Package

In business process package (see Figure 9) each business process transforms an item type (as resource package defines) from an initial state into a final state. Transformations may be decomposed in smaller transformations, where each of them corresponds to a change in the item state. When there are no more transformations to be performed, the item reaches its final state and the organization reaches the aim of its business.

Each business subprocess can involve several business transactions, also several actors. However, the set of organizational structure aspects and their values should remain constant in the business subprocess. A business subprocess can involve one or more organizational units if their organizational structure aspects do not vary. Additionally, each business subprocess has only one responsible.

A business process can be recursively decomposed in business subprocess, up to the business transaction level. A business transaction is the smallest business process unit of work. Each business transaction is responsible for one of the item (instance of item type as defines resource package) transformations. A business transaction can be decomposed in a partial order of atomic tasks and its whole execution is under the responsibility of a single actor. Nevertheless, a business transaction can receive as inputs several resources to be used in tasks execution. Last, but not least, it is a generalization of task.

A task describes a piece of work that forms one logical step within a process. It can be a "supertask" ─ composition of related tasks or a "simple task". While it is a simple task it can be associated with skill class (defined in the organizational package). This fact facilitates a dynamic choose of actors with correct abilities for task perform. Moreover, a simple task is called "manual" when it is not capable of automation, thus lies outside the scope of a workflow management system. When a simple task is capable of computer automation through workflow management system it is called automatic.

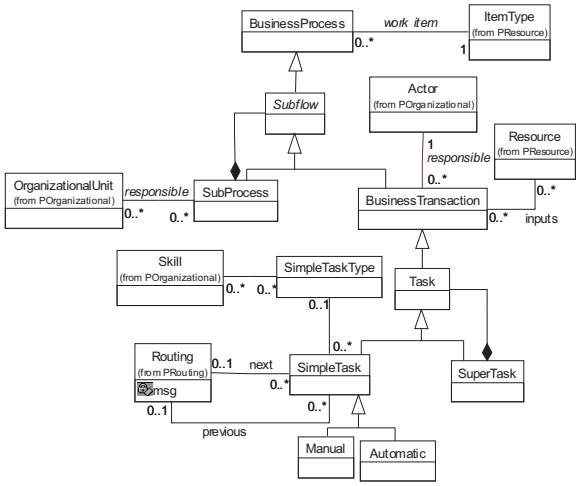

Figure 9: Business process package

4.5 Catalogue Package

Catalogue package (as shown Figure 10) describes whole classes used by a catalogue manager in the selection of the best design pattern from a catalogue of business subprocess patterns, as basis to model a certain business (sub)process he/she wants to accomplish. The business subprocess pattern selection is based on a set of parameters obtained from TMBP (e.g., kind of business subprocess, value of organizational structure aspect and kind of work item used in the subprocess). The set of parameters may vary according to the kind of subprocess.

After this, a subprocess builder extends the selected pattern with information on the partial order of business transaction. For each business transaction it must include: the work item manipulated, the input resources its internal tasks use, the actor responsible for tasks execution and the partial order among them.

In order to extend the business subprocess pattern the builder requires some input parameters: the selected business subprocess pattern, the organizational unit and the kind of work item. Further details about how to use the catalogue in practice are in [Th04].

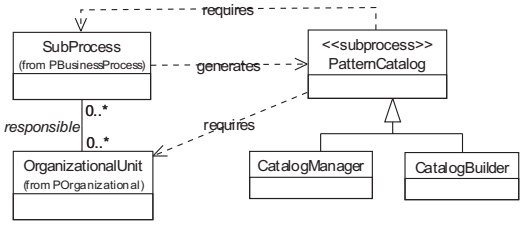

Figure 10: Catalog package

5 Business Process Modelling with TMBP

We are looking forward to implementation issues needed for automatic generation of business (sub)process based on business subprocess patterns stored in TMBP catalogue. Based on the methodology proposed by Eletronic Commerce Modelling (ECOMOD) project[14] (as shown Figure 11) we developed TMBP methodology for business process and workflow process design and implementation (as shown Figure 12): The methodology is composed of three steps:

1. Creation of business process models based on TMBP. The task of this step is the creation of business process models as described in section 4.5.
2. Automatic generation of BPEL4WS processes corresponding to the business process models defined in step 1. Section 5.1 exemplifies a TMBP business process (as shown in Figure 4) described as BPEL4WS process.
3. Execution of BPEL4WS process through workflow engine.

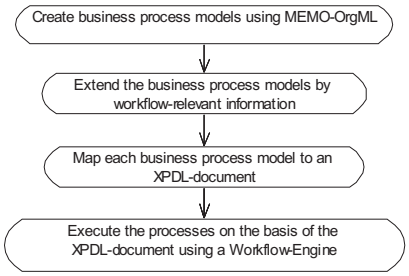

Figure 11: ECOMOD methodology

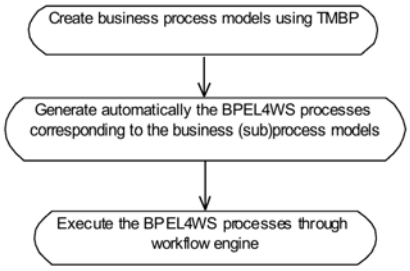

Figure 12: TMBP methodology

5.1 Mapping TMBP Business Process to BPEL4WS Process

This section presents some rules for mapping a TMBP process example (as shown in Figure 4) to a correspondent BPEL4WS process.

Rule for "parameter" mapping

In Figure 4 an organizational role (responsible for a document approval) is received as input parameter. In BPEL4WS this situation is represented with an `invoke activity` (as shown number 1 of Figure 13).

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[14] ECOMOD project was funded by the German National Research Foundation. The project focuses on the development of enterprise models as well as conceptual foundation for cross-organizational business processes and corresponding versatile platforms for electronic trading [Fr04]. The Multi-Perspective Enterprise Modelling (MEMO) was created in ECOMOD context. MEMO is a method for the modelling of organizations according to different views as well as different levels of abstraction [Ju04].

- **Mapping rule for "decision task"**

  The decison node (illustrated in Figure 4 as a diamond) is mapped to BPEL4WS as a `switch` statment.

- **Mapping rule for "record task"**

  According with Figure 4, the result of a decision can be an approval or a disapproval. If approved the signature or an indication of it needs to be recorded. In BPEL4WS this situation is mapped through an `operation` (`recordsignature`). A `variable` counts the number of signatures to be used in case of a disapproval (see number 2 in Figure 13).

- **Mapping rule for "anulation of performed task"**

  If a disapproval occurs all previous signatures (in case they exist) must be annuled. In BPEL4WS this situation can be expressed through a `while` statment and through an `operation` ("`anulSignature`" as shown number 3 and 4 of Figure 13).

Process Description (port type description and message description are left out).

```
<process name="documentApproval">

(1)<invoke partnerLink="reviewer"
   portType="itemReviewerPT"
   operation="reviewItem"
   variable="review"
   <correlations>
   <correlation set= "itemID" initiate="yes"/>
   </correlations> </invoke>
   <switch>
      <case condition =
      "bpws:getVariableProperty('review')="true"
         <sequence>
(2)      <invoke partnerLink="requester"
               portType="signaturePT"
               operation= "recordSignature"
                    from expression=
                    "bpws:getVariableData('signatureCount') +
                    bpws:getVariableProperty('auxSignatureCount'
                    )to variable='signatureCount'/>  </invoke>
                          </sequence> </case>
      <otherwise>
(3)      <while condition =
             "bpws:getVariableProperty('signatureCount')>0
             <sequence>
(4)          <invoke partnerLink="requester"
                    portType="signaturePT"
                    operation= "annulSignature"
                    from expression=
                    bpws:getVariableData('signatureCount') -
                    bpws:getVariableProperty('auxsignatureCount'
                    ) "/></invoke></sequence></while>
                    "bpws:getVariableData('signatureCount')= 0
      </otherwise>
      from expression=
      "bpws:getVariableData('numberOfOrganizationalRoles') -
      bpws:getVariableProperty('auxnumberOfSuperiorPositions')
      "/></switch></process>
```

Figure 13: TMBP process as BPEL4WS process

6 Summary and Outlook

The correct representation of business process through a suitable modelling technique is a key for the success of any workflow project. This paper addressed the use of business subprocess candidate patterns as a new approach to achieve accuracy in both business process modelling and workflow process modelling. The interesting point of the business process candidate patterns is that they focus on task flow description and are based on organizational structure aspects. The advantage of this approach is that it will lead to a better representation of the real business process executed in organizations, hence improving the workflow project quality.

Additionally, although the knowledge of some organizational structure aspects can help designers to correctly represent business process as well as workflow process, most existent business process and workflow process (meta)models support the use of this knowledge only in a limited way. This fact can threaten both the accuracy and efficiency of the whole business process and workflow process project. Aiming to remove this limitation, we proposed TMBP. The advantages of the metamodel are twofold: First we expect to provide a bridge between organizational structure aspects and business subprocess, minimizing the complexity of business process definition and at the same time improving the efficiency and quality of it. On the other hand the business subprocess pattern catalogue has been devised to enhance the business process and workflow process development.

In our final remark we demonstrated how BPEL4WS might be used in the description of executable business subprocess patterns that support organizational structure aspects. BPEL4WS will become the execution language for business (sub)processes with tool support and platform independency. Our approach automatically maps TMBP processes to BPEL4WS processes by generating executable BPEL4WS from TMBP specifications. Last, but not least, TMBP provides a high level specification that supports semi-automatic selection of patterns.

In the future we consider the investigation of new patterns to be used in workflow project. In that, we are currently thinking of investigate patters based on the process execution context (e.g., kind of software project and environment features). We believe that depending on the process execution context as well as the process phase development (e.g., in the software process development one of the phases is the requirement analyses) a specific methodology of development will be used in that phase (e.g., use case diagram of the methodology – Rational Unified Process (RUP) methodology [KRU 2003]). A further task could be the investigation of how TMBP and its workflow generation architecture could be adapted to support the new patterns

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