Context-aware Business Process Evaluation and Redesign

Kahina Bessai[1], Bruno Claudepierre[1], Oumaima Saidani[1], Selmin Nurcan[1,2]

[1] Centre de Recherche en Informatique
Université Paris I - Panthon Sorbonne
90, rue Tolbiac - 75013 Paris
[2] IAE de Paris
21, rue Broca - 75005 Paris
Kahina.Bessai@malix.univ-paris1.fr,
{Bruno.Claudepierre,Oumaima.Saidani,Selmin.Nurcan}@univ-paris1.fr,

Abstract. Current research on business process management (BPM) outlines the importance of business process reengineering and its role in improving business process. As well, requirements on context-awareness go forward including BPM in many research areas. That is why, in this paper, we introduce a methodology for BPR consisting on: (i) using the process context in order to discover the process nature, and (ii) using the workflow patterns (control and resource) for evaluating and enhancing the current process with respect to a given context.

1 Introduction

Business process (BP) development plays a fundamental role in the enterprise systems engineering. Enterprises should be adaptable and interoperable with current complex and dynamic environments. So that, their BPs need to be adequate to the context and flexible. Recent researches on BP stress the importance of these features [19, 14], and numbers of approaches were proposed in order to meet these requirements. Some of them focus on context-awareness [15, 18]. Others propose reuse mechanisms such as BP families [17], reference models [20] and workflow patterns [7]. Even if the proposed approaches and mechanisms are powerful, they focus only on one step of the BP life cycle, mainly the design one.

The needs for researches on both BP redesign and context-awareness are significant. Therefore, we introduce a first set of research issues as a starting point for context-aware BP reengineering. We make the assumption that the BP model is already designed, and we focus on the BP evaluation and redesign. The objective is to reengineer BP models allowing them to better support business requirements. In order to deal with the mentioned issues, we set the following investigating questions:

- How to detect, evaluate and locate the gap between the BP model and the actual business requirements?
- Using which mechanisms this gap can be purged?

- How to redesign the BP model with respect to the process execution context?
- What are the relevant features caracterising a BP context?
- Which support can provide the context related knowledge for BP evaluation and redesign?

Our approach consists in two principle steps: first, it identifies the BP context; second, it enhances the original BP model by using process chunks appropriate for this context. For this purpose, a prominent idea is the use of the workflow patterns [23]. Note that the workflow patterns have proven their effectiveness in the field of BPM for their reuse advantages. Each pattern has a generic semantic and is able to describe a process chunk. In this work we use them as an extension mechanism in the phase of redesign. For this purpose we associate to each pattern a *relevance degree* in a particular context of use. We will discuss the proposed approach in the remainder of the paper.

The paper is structured as follows. Section 2 discusses the background and our motivation. Section 3 presents an evaluation framework for patterns relevance with respect to the context of use. Section 4 introduces our approach for BP redesign. Finally section 5 concludes the paper.

2 Background and Motivation

In this section we provide a review of workflow patterns, context awareness, BP reengineering and our motivation.

Workflow pattern Workflow patterns are defined in [12] as "a mean of categorising recurring problems and solutions in modelling business processes ". They distinguish three family of patterns: *control, resource* and *data* patterns for representing the control and organisational perspectives. Workflow patterns were established with the aim of delineating the fundamental requirements that arise during BP modelling on a recurring basis [22, 13, 10].

This collection of patterns is used mainly as a formal basis for (i) understanding the requirements of the control-flow and resource perspectives (ii) evaluating the capabilities of BP modelling languages and web services standards [21]. We are interested in this paper to the use of these patterns for redesigning business processes in various contexts. The evaluation that we propose focuses on the control and resource patterns presented in [11, 21].

BP renginering (BPR) According to Hammer, "the reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed "[6]. BPR has been embraced by business organisations as an approach to implement and manage change [8, 3, 16]. A key issue in BPR is the 'how' question. BPR requires some methodology guidelines [3, 4]. The methodology that we propose in this paper consists on three steps :

- The As-Is step : define the process to be reengineered and evaluate its instances in order to discover its nature.
- The transition step : identify the weaknesses of the process model with respect to the trace of its instances and determine which behavior the process model has to integrate for its improvement.
- The To-Be step : improve the original process model using the selected patterns.

This methodology is based on a framework that evaluates the patterns relevance. We will define this framework in section 3.

Context-awareness and BP The context plays an important role in several disciplines like natural language semantics, artificial intelligence, knowledge management, and web systems engineering [15, 18]. It can be defined as any information that can be used to characterise the situations of an entity [19]. In the BP development, the context-awareness is relatively a new field of research. Even if the literature provides several references, the context related knowledge is taken into account only in the BP design step [2]. In our knowledge, none of the existing BP evaluation or redesign approaches are context-aware.

3 Evaluation of the Workflow Patterns Relevance

We introduce in this section an evaluation framework for workflow patterns according to the context related knowledge. In the proposed framework, the context captures the process nature. We mean by the process nature the taxonomy distinguishing between *production, administrative, collaborative and ad hoc* processes [1]. Let us remember that the production processes (PP) involve repetitive and predictable BPs. They implement the core processes of the entreprise. Administrative processes (AP) refer to bureaucratic processes where the steps to follow are well established and there is a set of rules known by everyone involved. Ad hoc processes (AHP) tend to deal with exceptions or unique situations and depends on the users involved. The collaborative process (CP) are mainly caracterised by the interaction between the involved participants [1, 9].
The proposed framework aims to answer the following questions: How to take into account the nature of the process when selecting workflow patterns to redesign the process?

To respond to this question we evaluate each workflow pattern in different contexts. In fact, the patterns relevance varies from a process nature to another.

As mentioned in section 2, our evaluation considers in a first step the resources and control patterns. Table 1 (resp Table 2) presents the relevance degree of the control (resp resource) patterns with respect to the process nature. The columns represent the process nature. The rows of Table 1 represent the control patterns, those of table 2 represent the resource patterns. We represent the patterns by numbers. The pattern names are given in appendix A. A cell indicates the relevance degree of a given pattern with respect to a given process nature.

Type Process/ Pattern	PP	AP	CP	AHP	Type Process / Patterns	PP	AP	CP	AHP
PC1	++	++	++	++	PC11	+	+	+	+
PC2	++	++	++	-	PC12	+	++	+	+
PC3	++	++	++	-	PC13	+	++	++	-
PC4	++	++	+	+	PC14	-	+	+	++
PC5	++	++	+	+	PC15	- -	-	+	++
PC6	-	+	++	++	PC16	- -	- -	-	++
PC7	-	+	++	++	PC17	- -	- -	+	++
PC8	-	+	++	++	PC18	-	-	+	++
PC9	-	+	++	++	PC19	-	-	+	++
PC10	-	+	++	++	PC20	+	+	+	++

Table 1. Relevance of control patterns with respect to the process nature

The values of the degree vary from "Not at all important" to "very important". The patterns can then be classified into four categories "Very important (++)", "Important(+)", "less important (-)" and "Not at all important (- -) ". The values set on Tables 1 and 2 are based on our experience in business process modelling and on the tacit knowledge we capitalised. We shall validate them (confirm/modify/infirm) based on an empirical study and statistical results.

4 Business Process Evaluation

In this section we discuss the evaluation of BP instances to discover the features of the process context. We extend the contextual plan described in [18]. The evaluation process consists in (i) identifying process nature and (ii) identifying workflow patterns for process redesign. We make two hypothesis : first, the process model impacts the process performance, second resources are allocated with respect to the process model.

4.1 Process Nature Identification

Which kind of measures can identify weaknesses of a process model? We relate the measures of the process instance performance to the context framework described in [18]. The objective is to identify the nature of the analysed process instances. We aim at determining the set of the appropriate patterns to redesign the original process model. Figure 1 shows the context tree used to identify criteria related to our study. We use three dimensions to understand the context of the process instances: (i) the *resource* dimension is related to human resources (communication, collaboration, knowledge and decision-making) and data support system (data sharing); (ii) the *task* dimension describes the repetitive aspect of the tasks and the documentation level; (iii) the *process* dimension is used to analyse the number of the process instances and the evolution. That is to say, the process is well defined or the process is defined during its execution.

Type Process/ Pattern	PP	AP	CP	AHP	Type Process/ patterns	PP	AP	CP	AHP
PR1	+	+	+	- -	PR22	+	+	-	-
PR2	++	++	++	-	PR23	- -	- -	++	+
PR3	-	-	+	++	PR24	++	+	-	- -
PR4	+	++	++	-	PR25	-	-	++	++
PR5	++	+	+	+	PR26	-	-	++	+
PR6	-	-	-	+	PR27	+	+	++	++
PR7	-	+	+	-	PR28	++	++	+	+
PR8	-	-	-	+	PR29	+	+	++	+
PR9	++	+	-	-	PR30	+	+	++	++
PR10	++	++	+	-	PR31	-	+	+	++
PR11	++	++	- -	-	PR32	-	+	++	+
PR12	-	-	+	++	PR33	- -	-	-	++
PR13	-	-	++	+	PR34	-	+	+	++
PR14	++	++	+	-	PR35	- -	- -	-	+
PR15	+	+	- -	-	PR36	+	+	+	+
PR16	+	+	-	-	PR37	+	+	+	+
PR17	++	++	+	-	PR38	++	+	-	-
PR18	+	+	++	- -	PR39	+	+	- -	- -
PR19	++	++	++	+	PR40	-	+	++	+
PR20	-	-	+	-	PR41	-	+	+	+
PR21	-	-	++	+	PR42	-	+	++	+
PR43	+	+	+	+					

Table 2. Relevance of resource patterns with respect to the process nature

We identify applicable type of process (production (PP), administrative (AP), collaborative (CP), ad hoc (AP) processes) by using context criteria described in Fig 1. We relate the context attributes (see Fig. 1) to the process nature. In the following, we study these relations (1,2, 3 and 4). Attributes are described in Table 3.

$$PP = SET(documentation; number\_of\_instances) \quad (1)$$

$$AP = SET(documentation; repetitiveness) \quad (2)$$

$$CP = SET(knowledge; structure; communication; data\_sharing; collaboration) \quad (3)$$

$$AHP = SET(communication; evolution; decision\_making;) \quad (4)$$

4.2 Selecting Pattern for Process Redesign

A process is enacted in a particular context for supporting business goals. The context can be constrained by the contextual goals depicted by organisation. We mean by context goal the business goals which are specific to a given context. In other way, the context can be related to the nature of the process. For instance, in the case of a production process: "the process must be well documented".

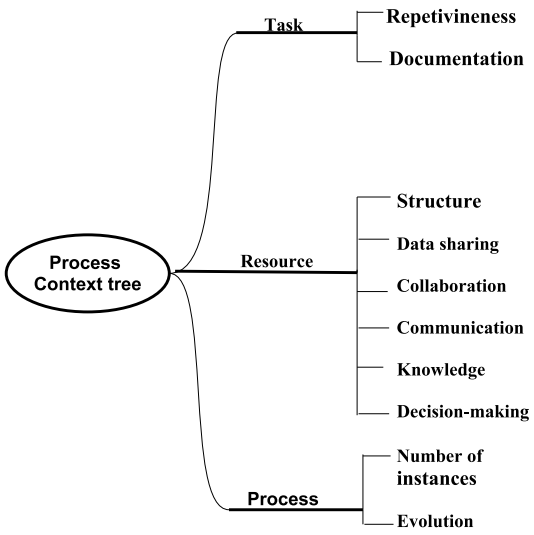

Fig. 1. Context tree for process nature identification

The context is composed by context attributes and each of them is related to a particular measure. In this case, the measure is the evaluation of a context attribute. In order to determine the values of the context attributes (see Table 3),

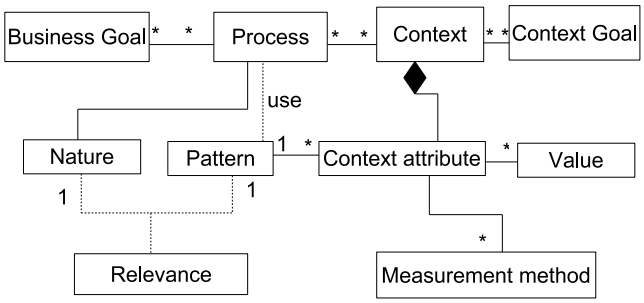

Fig. 2. Meta-model of pattern adequacy evaluation

appropriate measurement methods are required. These methods can be based on log files analysis, interviews with users, questionnaires, etc. The results of those measurements should be compared with the "most significant attributes" proposed in section 4.1 for each type of process. The next step is then the identification of the appropriate patterns to be used with respect to their relevance

Attributes	**Values**	**Comments**	**Measurement method**
Repetitiveness	Boolean	The repetitiveness aspect of a task	log analysis
Documentation	Enum{'none', 'task', 'process'}	Documentation level of a process	questionnaire
Structure	Enum{'group', 'person'}	Organisational structure of actors	questionnaire
Data sharing	Boolean	Data sharing support	log analysis
Collaboration	Enum{'high', 'medium', 'low'}	Level of collaboration between actors	log analysis
Communication	Boolean	Availability of communication between actors	log analysis
Knowledge	Enum{'presence', 'use', 'sharing'}	Level of knowledge usage	questionnaire
Decision-making	Rate of occurrence	The context of decision-making	questionnaire
Number of instances	Integer	Number of process instances	log analysis
Evolution	Enum{'static','dynamic'}	Process evolution during its execution	log/questionnaire

Table 3. Description of contextual attributes

for this type of process (Tables 1 and 2). In this section we have proposed an approach for the context evaluation in order to re-engineer process models by selecting workflow patterns. Figure 2 presents the meta-model of the proposed approach.

5 Conclusion

The work presented in this paper introduces a first set of research issues as a starting point for context-aware BP reengineering. We propose a framework for studying and evaluating the relevance of control and resource patterns with respect to the process nature. As shown in Tables 1 and 2, some patterns are relevant for only one process nature. For example the pattern Deferred Choice (PC16) is important for ad hoc processes, and not very relevant for production processes.

This innovative study is used for identifying the weaknesses of a process model and determining which patterns the latter has to include for its improvement. We introduced a methodology for BPR. It consists in (i) using the process context in order to discover its nature; and, based on the proposed evaluation: (ii) selecting the adequate patterns, and (iii) redesigning the process model. The selected patterns are only those which are relevant to the nature of the process in a particular context.

We identified some limitations in our research. First the proposed BPR methodology requires further development and experimental testing in order to determine its effectiveness. Second, our evaluation of the patterns relevance is based on subjective interpretations, which require now some empirical evidence. Third, we constrained the process evaluation to the evaluation based on the workflow resource and control patterns that in sequence limits the generalisation of the findings.

In our future research, we will extend this analysis to include also workflow data patterns in order to complete the evaluation criteria.

References

1. Alonso.G, D. El Abbadi, and Mohan.C , Fonctionality and Limitation of Current Workflow Management Systems, IEEE Expert (1997).
2. Balabko.P , Context Based Reasoning in Business Process Models, Las Vegas, USA. IEEE IRI (2003).
3. Davenport.T, Process Innovation: Reengineering Work through Information Technology. Harvard Business School Press. USA.(1992)
4. Evans.K, Reengineering and cybernetics, American Programmer (Special issue on BPR), 6, 11, 10-16. (1993)
5. Fitzgerald.B, and C.Murphy, Business Process Reengineering, The Creation and Implementation of a Methodology, The Canadian Journal INFOR (Information Systems and Operational Research Springer (1996).
6. Hammer.M, J.Champy, Reengineering the Corporation: A Manifesto for Business Revolution, Harper Collins,London (1993).
7. Heloisa.L , Cirano Iochpe ,T.Reichert, Workflow Patterns for Business Process Modeling, 8th Workshop on Business Process Modeling, Development, and Support (BPMDS'07)(2007).
8. Kohliet.R, E.D.Hoadley, Business process re-engineering concepts and tools effectiveness: a survey of practitioners,Knowledge and Process Management.Volume 4, Issue 4, Pages 278 - 285 (1997)
9. Nurcan.S, A survey on the flexibility requirements related to business processes and modeling artifacts. Proceedings of the 41st Annual Hawaii International Conference on System Sciences, Big Island, Hawaii, USA, 7-10 January (2008)
10. Russell, A.Hofstede, D.Edmond and Van der.Aalst, Workflow Data Patterns, QUT Technical report, Queensland University of Technology (2004).
11. Russell, A.Hofstede, D.Edmond and Van der.Aalst, Workflow Resource Patterns , BETA Working Paper Series, WP 127, Eindhoven University of Technology, Eindhoven(2004).
12. Russell, A.H.M. ter Hofstede, W.M.P. van der Aalst, and N. Mulyar, Workflow Control-Flow Patterns , BPM Center Report BPM-06-22 , BPMcenter.org (2006).
13. Russell.N, W.M.P. van der Aalst, A.H.M. ter Hofstede, and D.Edmond, Workflow Resource Patterns: Identification,Representation and Tool Support , Proceedings of the 17th Conference on Advanced Information Systems Engineering (CAiSE05) (2005).
14. Regev. G, Wegmann, A Regulation-Based View on Business Process and Supporting System Flexibility", Proceedings of the CAiSE'05 Workshop (2005).

15. Rosemann, M., Becker, J.: Context-Aware Process Design Exploring the Extrinsic Drivers for Process Flexibility. Proceedings of the CAISE'06 Workshop on Business Process Modelling, Development, and Support (BPMDS06) (2006).
16. C.Rolland, P. Loucopoulos, V. Kavakli, S.Nurcan, Intention based modelling of organisational change: an esperience report, Proceedings of the fourth CAISE/IFIP 8.1 International Workshop on Evaluation of Modeling Methods in Systems Analysis and Design (EMMSAD 99), Heidelberg, Germany, june 14-15, (1999).
17. Rolland.C, N.Prakash, On the Adequate Modeling of Business Process Families, 8th Workshop on Business Process Modeling,Development, and Support (BPMDS07)(2007).
18. Saidani.O, S. Nurcan, Towards Context Aware Business Process Modelling, Workshop on Business Process Modelling, Development, and Support (BPMDS), Trondheim, Norway,(2007).
19. Schmidt.R, Holistic Inquiry into Business Process Design. BPMDS Series of International Workshops: Eighth Workshop on Business Process Modeling, Development, and Support(BPMDS 07) (2007).
20. Soffer, P., Reinhartz-Berger, I., Sturm, A, Facilitating Reuse by Specialization of Reference Models for Business Process Design, 8th Workshop on Business Process Modeling, Development, and Support(BPMDS07)(2007)
21. Van der Aalst, A.P. Barros, A.H.M. ter Hofstede, and B.Kie-puszewski, Advanced Workflow Pattern , 7th International Conference on Cooperative Information Systems,CoopIS (2000).
22. Van der Aalst, A.P. Barros, A.H.M. ter Hofstede, and B.Kie-puszewski, Workflow Patterns, BETA Working Paper Series, WP 47, Eindhoven University of Technology, Eindhoven(2000).
23. Van der Aalst, Business Alignement: Using Process Mning as a Tool for Delta Analysis and Conformance Testing, Requirements Engineering Journal, 10(3):198-211, 2005.

Appendix A

	Control Patterns
PC1	Sequence
PC2	Parallel Split
PC3	Synchronisation
PC4	Exclusif Choice
PC5	Simple Merge
PC6	Multi-Choice
PC7	Structured Synchronising Merge
PC8	Multi-Merge
PC9	Structured Discriminator
PC10	Arbitrary Cycles
PC11	Implicit Termination
PC12	Multiple Instances without Synchronisation
PC13	Multiple Instances with a priori Design-time Knowledge
PC14	Multiple Instances with a priori Run-Time Knowledge
PC15	Multiple instances without a priori run-time knowledge
PC16	Deferred Choice
PC17	Interleaved Parallel Routing
PC18	Milestone
PC19	Cancel Activity
PC20	Cancel Case

	Resource Patterns
PR1	Direct Allocation
PR2	Role-based Allocation
PR3	Deferred Allocation
PR4	Authorisation
PR5	Separation of Duties
PR6	Case Handling
PR7	Retain Familiar
PR8	Capability-based Allocation
PR9	History-based Allocation
PR10	Organisational Allocation
PR11	Automatic Execution
PR12	Distribution by Offer-Single Resource
PR13	Distribution by Offer-Multiple Resource
PR14	Distribution by Allocation-Single Resource
PR15	Random Allocation
PR16	Round Robin Allocation
PR17	Shortest Queue
PR18	Early Distribution
PR19	Distribution on Enablement
PR20	Late Distribution
PR21	Resource-Initiated Allocation
PR22	Resource-Initiated Execution - Allocation Work Item
PR23	Resource-Initiated Execution-Offered Work Item
PR24	System-Determined Work List Management
PR25	Resource-Determined Work List Management
PR26	Selection Autonomy
PR27	Delegation
PR28	Escalation
PR29	Deallocation
PR30	Stateful Reallocation
PR31	Stateless Reallocation
PR32	Suspension/ Resumption
PR33	Skip
PR34	Redo
PR35	Pre-Do
PR36	Commencement on Creation
PR37	Commencement on Allocation
PR38	Piled Execution
PR39	Chained Execution
PR40	Configurable Unallocated Work item Visibility
PR41	Configurable Allocated Work Item Visibility
PR42	Simutaneous Execution
PR43	Additional Resources