Towards the Enhancement of Process Families Support using Change Patterns

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Abstract. This paper presents the ongoing research on change patterns for process families. A process family is a collection of related process model variants sharing a number of commonalities (i.e., modeling elements found in all process variants), but also showing differences due to their application context. The research goal is to provide a set of change patterns for dealing with process families regarding all process perspectives and along the entire process lifecycle. Recently, generic and language-independent adaptation patterns were successfully introduced for creating and evolving single business process models. However, they are not sufficient to cope with the variability-specific aspects introduced by process families. The main goal is hence to define a set of a complementary set of generic, language-independent patterns specifically tailored towards the needs of process families. When used in combination with existing adaptation patterns, *change patterns for process families* will enable the modeling, configuration and evolution of process families at a high-level of abstraction regarding all process perspectives. Further, they will serve as reference for implementing tools or comparing proposals managing process families.

Keywords: Business Process Variability, Process Families, Patterns, Process Change

1 Introduction

The increasing adoption of process aware information systems (PAIS) in recent years has resulted in large process model repositories with numerous collections of business process (BP) models [20, 7]. Since these models frequently vary depending on the application context [11, 20], existing repositories often comprise large collections of related *process model variants* (*process variants* for short). Usually, such process variants have common parts and pursue same or similar business objectives, but at the same time differ regarding the application context in which they are used [11, 20], e.g., countries' regulations, services delivered, or customer categories [17, 7, 19].

A collection of *process variants* is denoted as a *process family*. In large companies, a process family might comprise dozens or hundreds of process variants [17]. For example, a process family for vehicle maintenance may comprise more than 900 variants with country-, garage-, and vehicle-specific differences [12]. In turn, [16] reports on a process family comprising more than 90 variants for planning and handling medical examinations.

Properly dealing with process families constitutes a fundamental challenge to reduce process modeling and maintenance efforts in the context of PAISs. Trying to design, implement, and maintain each process variant of a process family from scratch would be too inefficient and costly for enterprises. Thus, there is a great interest in capturing common process knowledge only once and re-using it in terms of a *configurable process model* representing the complete process family.

In recent years, motivated by the shortcomings of traditional BP modeling approaches [12], proposals exist for dealing with process families along the BP lifecycle; e.g., [21, 12]. Common to them is the extension of BP modeling languages with variability-specific constructs that enable the creation of configurable process models. By treating variability as first class citizen at any BP perspective (e.g., control-flow, resources, data), these extensions help avoiding redundancies, fostering reusability, and reducing modeling efforts. However, introducing variability-specific constructs implies additional complexity concerning the modeling language. To make these proposals amenable for industrial strength use, the quality of created models becomes crucial. In turn, this necessitates proper support for PAISs engineers when creating and modifying process families.

In [28], a language-independent and empirically grounded set of *adaptation patterns* was proposed allowing for the creation and modification of single BP models [28]. Adaptation patterns not only allow creating and modifying BP models at a high level of abstraction, fostering model quality by ensuring correctness-by-construction, but also provide systematic means for realizing change operations optimized for a specific modeling language as well as comparing existing approaches in respect to BP flexibility [8]. Further, adaptation patterns have served as basis for implementing changes in different stages of the process lifecycle; e.g., model creation [25], process configuration [12], process instance change [5], model evolution [14], model refactoring [29], change reuse [2], model comparison [13], and change analysis [10]. However, while adaptation patterns are well suited for creating and modifying single BP models, they are not sufficient to cope with the specific needs for dealing with process families [3].

In the vein of adaptation patterns, the PhD thesis is aimed to provide a complementary set of generic, language-independent patterns specifically tailored towards the needs of process families along the process lifecycle. Used in combination with the existing adaptation patterns, change patterns for process families will enable the modeling, configuration as well as evolution of process families at a high level of abstraction. In particular, they may serve as reference for specific language-dependent implementations, build the foundation for

realizing changes along the BP lifecycle, and foster the comparison of existing proposals for BP variability.

The paper is organized as follows. Goals of the thesis are described in Section 2. Section 3 presents related work. In Section 4, the research methodology is described. Section 5 outlines the preliminary results of the thesis. Finally, Section 6 concludes the paper.

2 Problem Statement and Research Goals

The main research goal of the PhD thesis is to provide a set of generic and language-independent change patterns for dealing with process families, regarding all process perspective and along the entire process lifecycle. For such purpose, the following main research question will be investigated: *"How can change patterns enhance the support for process families?"*. To answer this question, apart from the definition of respective patterns, proper implementation support is needed to bring their practical value. Thus, based on this implementation, a set of experiments may be conducted to measure the efforts of handling variability with these patterns. Concretely, the impact of using change patterns on process families may be studied regarding all process perspectives and along the entire process lifecycle. Therefore, the research tasks to carry out in the PhD thesis are (1) to define the set of generic and language-independent change patterns for process families regarding all process perspectives and along the entire process lifecycle, (2) implement a prototype tool including these patterns, and (3) perform experiments to study the impact of patterns when modeling, configuring and evolving process families.

3 Related Work

Closely related to this thesis is research on adaptation patterns, workflow patterns, and process variability.

Adaptation patterns (AP) [27] allow structurally changing process models using high-level change operations instead of low level change primitives (e.g., add or delete node). They cover the basic use cases for creating and modifying process models. In addition, adaptation patterns can be applied along to the entire process lifecycle, i.e., the region to which adaptation patterns may be applied can be chosen dynamically. Hence, adaptation patterns are well suited for realizing process changes at both build- and run-time. The PhD thesis complements adaptation patterns with a set of change patterns covering variability needs in process families.

Workflow patterns were introduced for analyzing the expressiveness of process modeling languages. Patterns cover different perspectives like control-flow [1], resources [23], data [22], time [15], and exceptions [24]. However, these patterns are not sufficient for effectively modeling and modifying process families [3]. They do not consider variability-specific constructs introduced by process families and hence are complementary to change patterns for process families.

Proposals dealing with BP variability exist for modeling, configuring, executing and maintaining process families [12, 21]. In [8], a combination of workflow-, rule-, and event-modeling is presented to customize process variants for a given execution context. In addition, there are refactoring techniques [29] to remove redundancies among process variants in large process model repositories. Unlike these proposals, the goal of the thesis is to provide a set of change patterns for process families that provide language-independent means to model and evolve process families at a high level of abstraction.

As it is shown, there are not works which have addressed the definition of change patterns that support process families at a high-level of abstraction along the BP lifecycle and at any BP perspective.

4 Research Methodology

This PhD thesis will follow the design science principles for the development of research solutions. It consists of a set of stages based on the methodology proposed by *Peffers et al.* [18]. Figure 1 shows these stages and the main research tasks to fulfill in each one of them. Tasks underlined with dark lines have been already accomplished; tasks underlined with dashed lines have been started while tasks non underlined are included in future plans. It is likely that further research will imply additional tasks to be accomplished.

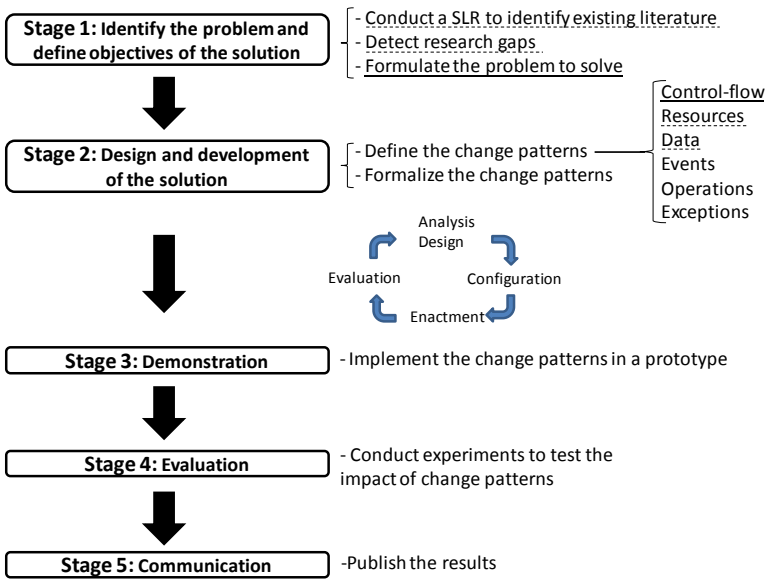

Fig. 1. Research methodology

Stage 1: Identify the Problem and Define Objectives of the Solution
In this first stage, based on literature review, the problem to be solved (i.e., dealing with process families) will be formulated and the requirements for a possible solution (i.e., change patterns) will be stated. For such purpose, a *Systematic Literature Review* (SLR) will be conducted to identify, evaluate, and interpret the state of the art on BP variability and process families. This will help in understanding what is already available and what can be possibly reuse to define the change patterns for process families. Meetings with PAIS engineers will help as well to understand their needs and what they expect from such change patterns for process families.

Stage 2: Design and Development of the Solution
At this stage, change patterns for process families will be defined based on the objectives defined in a previous step. Concretely, for each process perspective, the set of patterns that allow modifying, configuring, and, evolving configurable process models at a high level of abstraction will be defined. To obtain unambiguous change pattern descriptions and ground pattern implementation as well as pattern-based analysis on a sound basis, a formal semantics is needed. This formalization should be independent from any process meta model and thus allow implementing the set of change patterns (for every process perspective) in a variety of process support tools. In addition, change patterns for process families are intended to be applied along the entire process lifecycle and hence do not have to be pre-planned; i.e., they may be applied at runtime. Further, change patterns for process families are expected to ensure a set of properties such as correctness, consistency, robustness, reversibility, traceability and automation (whenever possible). For such purpose, different techniques (e.g., index structures [6]) will be studied to reduce the impact of change patterns in the configurable process model and to ensure such properties.

Stage 3: Demonstration
This stage will demonstrate that the identified problem is solved and the requirements are met. To ensure that the proposed patterns–despite their generic nature–are specific enough to cover existing proposals, they will be applied to a set of existing well-known proposals dealing with process families, e.g., C-EPC [21], Provop [12]. For such purpose, change patterns will be implemented in a prototype that will allow bringing the practical value of them as well as to show their feasibility.

Stage 4: Evaluation
During the evaluation, an experimental approach will be followed. Experiments will be conducted to test the impact of using proposed patterns on the creation, configuration, and evolution of configurable process models. Concretely, studies to empirically assess the understanding, maintainability, and scalability of process families using change patterns will be performed. For such purpose, two

different groups of PAIS engineers will be required. The first group will develop modeling and maintainability task of case studies of process families without the proposed change patterns. The second group will do the same tasks using the patterns. When both groups are ready, the quality of both results will be compared in order to find their similarities and differences. In addition, based on cognitive psychology [9, 26], the mental effort of both groups will be measure as well. This type of experiments will allow determining the dis/advantages of using proposed change patterns. During this stage, special attention will be paid to the feedback obtained from the experiments in order to improve the definition of the change patterns for process families.

Stage 5: Communication
In order to progressively validate the results of the research, scientific contributions at the different stages will be published in peer-reviewed journals and conferences. In addition, relevant collaboration events initiated by international institutions (e.g., FP7) or other national projects and programs will be attended.

5 Preliminary Results

This section presents the preliminary results of the already performed research work. Concretely, it describes the change patterns defined regarding the control-flow perspective of BPs. This perspective was selected first since it is the perspective mostly addressed by existing proposals dealing with process families.

Nine change patterns considered as relevant for dealing with changes the control-flow of a process families were defined. To ensure that the latter are expressive enough to deal with the specific needs of process families, as basis, four variability-specific language constructs (frequently used by existing proposals to capture the variability within a process family) were identified: *configurable region, configuration alternative, context conditions,* and *configuration constraints.* Based on these constructs, the control-flow change patterns were divided into three categories: insertion, deletion, and modification of variability-specific parts of a configurable process model (e.g., INSERT Configurable Region). Afterwards, we applied these patterns to two well-known proposals for dealing with BP variability (i.e., C-EPC [21] and Provop [12]) to demonstrate that the proposed patterns are indeed generic. Thus, control-flow change patterns intend to be complete regarding the control-flow perspective and cover all changes related to commonly used variability-specific language constructs. This work was done in collaboration with Profs. Barbara Weber and Manfred Reichert and it resulted in a publication in the *Working Conference of Business Process Modeling, Development, and Support* (BPMDS'13) [4].

Further, currently the focus of the research in on other process perspectives such as resources or data. Concretely, recurring situations of resources and data along the process lifecycle that may be solved through the use of change patterns are being identified; e.g., modeling the different resources that may execute a task, resources allocation during process configuration, context-dependent input

and output data, semantic constraints, and resources and data run-time configuration. In addition, the results of a SLR that will show the state of the art in the BP variability area are being processed.

6 Conclusions

This paper describes the research work which has as a main goal the development of a set of change patterns for dealing with process families. These patterns are intended to cover every BP perspective at any stage of the process lifecycle. Up to now, a set of nine patterns for modeling and evolving with the control-flow perspective of process families have been defined. The rest of process perspectives will be covered in a near future. Further, the complete set of *change patterns for process families* will be implemented and evaluated through experiments investigating the potential of proposed patterns. Similar to existing adaptation patterns, change patterns for process families are expected to have the potential to speed up the creation as well as modification of configurable process models. In addition, they may serve as benchmark for evaluating change support in existing languages and tools dealing with process families as well as for facilitating their systematic comparison by providing a frame of reference.

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