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Managing Process Model Compliance in Multi-Standard Scenarios Using a Tool-supported Approach

Authors:
Martin Kowalczyk
Silke Steinbach

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Fraunhofer IESE is directed by
Prof. Dr. Dieter Rombach (Executive Director)
Prof. Dr. Peter Liggesmeyer (Scientific Director)
Fraunhofer-Platz 1
67663 Kaiserslautern

Abstract

The increasing number of standards and requirements makes compliance management in software organizations complex, time-consuming, and costly. This paper describes a tool-based approach for systematic compliance management and initial evaluation results for the suggested approach.

Keywords: Software Process Management; Process Model Maintenance; Compliance Management

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1 Introduction

Nowadays organizations must increasingly deal with multi-standard scenarios in which their software processes have to comply with a multitude of requirements from different international and national standards. These include general software development standards (e.g., ISO/IEC 12207 or ISO/IEC 15504) and standards dealing with more specific topics (e.g., IEC 61508 or ISO 26262 for functional safety). In mature safety- and security-critical domains, organizations typically have to comply with several such standards. Process guides, which document an organization's process models, must fulfill requirements that are demanded by external standards.

We focus on the creation and maintenance of compliance between process guides and standards in multi-standard scenarios. This is a major challenge and is becoming increasingly cost-intensive due to the growing number of standards [1]. This situation is aggravated by the fact that usually only experienced process engineers in an organization are assigned the task of compliance management, as they know the most about processes. This creates a bottle-neck with respect to resource availability and finally leads to situations in which compliance management is neglected. If compliance management is not performed systematically, compliance erosion is likely to happen. This means that over the course of time, the compliance of an organization's process model will decrease, which is often observed in industrial practice [2]. There are two main reasons that lead to compliance erosion:

- External standard(s) change, e.g., due to an update of the respective standard(s), but these changes are not reflected within the organization's process guide(s).

- The organization makes changes to its process model(s) or guide(s), but these changes are not in line with several requirements from all the standards the organization has to comply with.

This paper suggests a systematic, tool-based approach for compliance management in multi-standard scenarios that aims at improving the efficiency and effectiveness of compliance management. An additional goal is to reduce the involvement of experienced process experts by making it possible to assign routine compliance management tasks to less experienced process engineers.

In the following, Section 2 presents related work. Section 3 gives an overview of the approach. Section 4 presents the evaluation approach and initial results. Finally, Section 5 provides a summary and an outlook on future work.

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2 Related Work

The challenge of working with multiple standards or process models has been reported by several authors (e.g., [1, 2]). The current approach for managing multi-standard scenarios is to reduce complexity by harmonizing related standards into consistent lists of requirements by comparing the respective standards and consolidating their requirements by removing redundancies. This approach is particularly beneficial when the targeted standards are quite similar. In such cases, large overlapping leads to a reduction of redundancies. In situations that are characterized by heterogeneous standards, a pure harmonization strategy will only have limited benefits. Typically, organizations need to consider standards from different domains, which consequently only have a limited number of redundancies. In these cases, the reduction of complexity that can be achieved through harmonization is limited.

The approach described in this paper is based on the work presented in [3] for tracing process model evolution and focuses on working with multiple standards. It can complement harmonization by using harmonized sets of requirements as one type of input for compliance management.

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3 Compliance Management Approach

The overall compliance management approach consists of two phases, a specification phase and a maintenance phase. In the specification phase, compliance relations are defined and compliance is initially evaluated using the provided tool support (PET). This tool support focuses on scenarios that use word-based process descriptions, which are still very common in industrial practice. In the maintenance phase, compliance can be managed systematically for three maintenance scenarios by using this tool support (PET). The addressed scenarios encompass (S1) standard change, (S2) ad-hoc process guide change, and (S3) planned process guide change.

3.1 Specification Phase

In order to obtain trustable results, the specification phase must be performed or supervised by a process expert. During this phase, three activities can be distinguished:

1. Define requirements set: The process engineer defines the relevant set of standards that he would like to address. From these standards he needs to elicit the respective requirements and document them in requirements lists.

2. Specify compliance relations: The process engineer performs a section-wise analysis of the organization's process guide with respect to his defined sets of requirements and specifies compliance relations. Each relation specifies the related standard, requirement id, influence (positive, negative, neutral), and whether the relation is sufficient or supporting with respect to compliance. These requirements relations are documented in a table using the XML format, which can also be read by a standard word processing program. Our tool support provides a template for these tables that can be easily added to a word-based process guide.

3. Perform initial analysis: The requirements lists and the process guide document with the specified compliance relations are imported into the tool and an initial compliance analysis is performed. The tool evaluates all relationships and provides tabular and graphical compliance analysis results. In particular, the results of the initial analysis contain a list of candidates that need further manual compliance re-evaluation. The tool supports the process engineer during these re-evaluations.

The finalization of the initial analysis updates the overall set of compliance relations and closes the specification phase. Subsequently, the tool can be used for

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compliance management and tasks can be handed over to less experienced engineers.

3.2 Maintenance Phase

The maintenance phase addresses the three maintenance scenarios (S1) standard change, (S2) ad-hoc process guide change, and (S3) planned process guide change. For each of these scenarios, the following activities need to be performed:

1. Identify changes: In all three scenarios, changes occur that need to be identified. In (S1), the updated standard needs to be analyzed with respect to changes in requirements. In (S2) and (S3), the relevant sections of the process guide in which changes have been performed (S2) or will be performed (S3) need to be identified.

2. Analyze change impact: Tool support is used to identify the impact of the changes. Using the tool in (S1) provides those process guide sections that are impacted by requirements changes. Subsequently, the previously defined list of requirements can be updated to reflect changed, added, or removed requirements. Using the tool in (S2) and (S3) helps to identify the requirements that are in the scope of a process guide change. In (S2), the change has already been performed and the tool provides the possibility to identify the impact of such changes. In (S3), this impact analysis is performed upfront and can therefore be part of the rationale for process changes.

3. Update compliance relations: Compliance relations that are impacted by a change of a standard (S1) or a process guide (S2) need to be updated. Additionally, cases in which new relations need to be specified can be identified easily by using the analysis capabilities of the tool, as it provides a checklist of missing relations.

These three maintenance phase activities allow managing standard compliance systematically. If a new standard or process guide is to be included in the existing set, the overall process starts again with the specification phase.

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4 Evaluation

4.1 Evaluation Approach

The purpose of the evaluation was to find out if the suggested tool-based approach provides the expected benefits with respect to efficiency, effectiveness, and suitability for novices. The object of the evaluation was the tool support (PET) for compliance management in scenarios that deal with changes (compare S1-S3).

The experimental design focused on three hypotheses:

H1 (efficiency): The identification of changes is more efficient when using PET than paper-based identification of changes. Efficiency is measured by how much time is needed to identify changes.

H2 (effectiveness): The identification of changes is more effective when using PET than paper-based identification. This means that if PET is used, more corresponding sections will be found. Effectiveness is measured by checking the completeness and correctness of the task results compared to a sample solution.

H3 (suitability for novices): PET is also suitable for novices, not only for experts who are very familiar with specific standards and norms, because it is easy to use and provides correct results. Suitability for novices is evaluated by means of the effects concerning efficiency and effectiveness. Additionally, the ease of use of PET was evaluated based on the Technology Acceptance Model (TAM) [4].

The design consisted of a comparing paper-based and tool-based task performance, followed by a questionnaire and a semi-structured interview. The current sample consisted of two experts (senior process engineers) and two novices (computer science students). We plan to replicate this evaluation.

4.2 Evaluation Procedure

The evaluation was conducted at our institute and the subjects worked on their assignments during the same time. At the beginning, all subjects were informed about the evaluation procedure and received the materials (one standard for functional safety and one document referring to that standard). After a reading period (approx. two hours), the subjects were given twelve tasks (six paper-based and six tool-based). The assigned tasks varied in the level of diffi-

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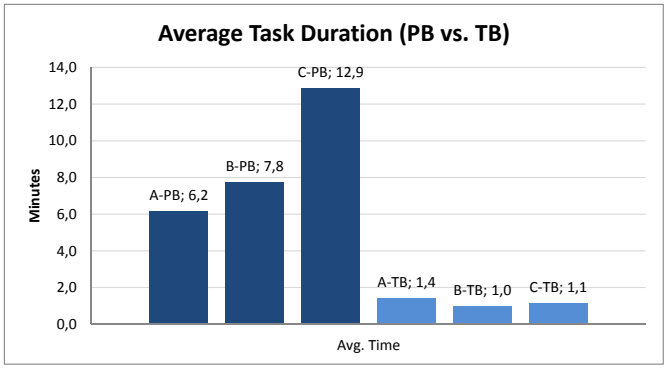
culty in order to differentiate the complexity of the changes (Task level A: Only one change in one section; Task level B: Several changes in one section; Task level C: Several changes in several sections) The subjects had to identify all relevant sections of the referring document possibly requiring correction in order to maintain conformance between both documents. First they had to perform the paper-based tasks, then the tool-based tasks.

4.3 Evaluation Results

H1 (efficiency): Comparison of the task durations for each task level shows a clear difference between the paper-based and the tool-based tasks (see Fig. 1). Particularly evident is the difference on task level C. On average, experts and novices needed 12.9 minutes to find all matching sections. Using PET helped to reduce task performance time for all tasks to less than 1.5 minutes.



	A-PB	*A-TB*
Expert	4,7	1,0
Novice	7,7	1,8
	B-PB	*B-TB*
Expert	5,5	1,0
Novice	10,0	1,0
	C-PB	*C-TB*
Expert	6,8	1,0
Novice	19,0	1,3

Fig. 1. Comparison of task durations: Total averages (left) vs. expert-level averages (right).

H2 (effectiveness): Neither the experts nor the novices found all matches in the paper-based task fulfillment (see Fig. 2, left). The higher the task level, the lower the matching rate. The experts found only 50% of all correct matches on the A and B levels, while the novices found no correct matches on the C level. Using the PET tool helped to nearly achieve 100% completeness and correctness on the A and B levels (except for the novices achieving only 83.3% on the A level). Both, experts and nov-ices achieved 75% correctness and completeness on the C level (see Fig. 2, right).

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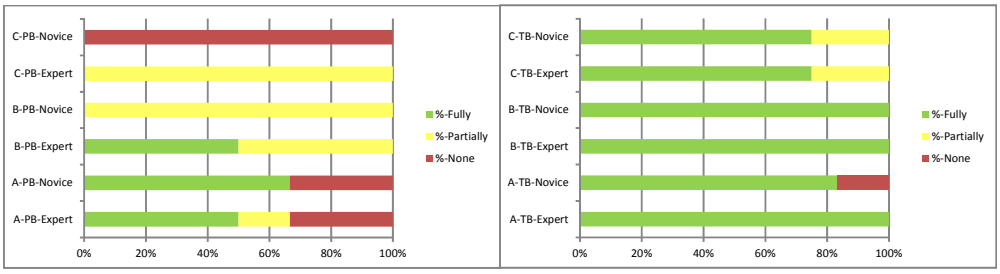

Fig. 2. Identified changes: Paper-based (left) vs. tool-based (right).

H3 (suitability for novices): As already shown, the results of the experts and the novices achieved higher correctness and completeness when using PET. Both experts and novices benefitted from time savings (see Fig. 1). The novices saved even more time as it took them longer to identify changes without tool support (see Fig. 1, right).

The analysis of the TAM questionnaire shows very good results in all four dimensions (ease of use: 4.25, perceived usefulness: 5, attitude towards using: 4.75, and intention to use: 3.75).

As part of the qualitative feedback, the experts and novices rated the overall performance of PET as “very good” (3x) and “good” (1x). In their opinion, PET supports the identification of changes very well. The actual change to maintain compliance still has to be done by an expert. Nevertheless, the experts expect a total efficiency gain of 20-30% on the complete maintenance activity. All subjects trusted the results because the upfront modeling of relations had been done by a domain expert.

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5 Summary and Outlook

This paper presented a tool-supported approach for systematic management of process model compliance in multi-standard scenarios. This approach is part of ongoing research work and the results of an initial empirical evaluation have been presented. These preliminary results show that the tool supports experts and even novices in identifying changes in reference documents very efficiently and very effectively. Based on our results from the current development and evaluation, further research work and developments are planned.

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References

1. M. T. Baldassarre, D. Caivano, F. J. Pino, M. Piattini, und G. Visaggio, „Harmonization of ISO/IEC 9001:2000 and CMMI-DEV: from a theoretical comparison to a real case application“, Software Quality Journal, July 2011.

2. J. Siviy, P. Kirwan, L. Marino and J. Morley, “The value of harmonization multiple improvement technologies: A process improvement professional’s view,” Software Engineering Institute Carnegie Mellon, 2008.

3. O. Armbrust, A. Ocampo, and M. Soto, “Tracing Process Model Evolution: A Semi-Formal Process Modeling Approach,” Proc. ECMDA Traceability Workshop, Nov. 2005.

4. V. Venkatesh and F.D. Davis, “A theoretical extension of the technology acceptance model: Four longitudinal field studies”, Management Science 46(2), 2000.

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