

Model-supported Process Adoption and Assessment in the Context of Multiple Practice Repositories

Von der Fakultät für Mathematik, Informatik und Naturwissenschaften der RWTH Aachen University zur Erlangung des akademischen Grades einer Doktorin der Naturwissenschaften oder einer Doktorin der Ingenieurwissenschaften genehmigte Dissertation

vorgelegt von

Simona Cristina Jeners (geb. Pricope), M. Sc.

aus Iași, Rumänien

Berichter: Univ.-Prof. Dr. rer. nat. Horst Lichter

Prof. Luigi Buglione, PhD

Tag der mündlichen Prüfung: 17. Dezember 2014

Aachener Informatik-Berichte, Software Engineering

herausgegeben von
Prof. Dr. rer. nat. Bernhard Rumpe
Software Engineering
RWTH Aachen University

Band 21

Simona C. Jeners

**Model-supported Process Adoption and Assessment
in the Context of Multiple Practice Repositories**

Shaker Verlag
Aachen 2015

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

Zugl.: D 82 (Diss. RWTH Aachen University, 2014)

Copyright Shaker Verlag 2015

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publishers.

Printed in Germany.

ISBN 978-3-8440-3481-3

ISSN 1869-9170

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen

Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9

Internet: www.shaker.de • e-mail: info@shaker.de

Summary

Although software products exist for more than 60 years, their successful development within a software project is still a challenge. A reason for this high failure rate might be poor software processes and the lack of systematic software process improvement. Considerable attention has been given to software process improvement in the last years and thus, practice repositories, such as CMMI-DEV, SPICE, COBIT, ITIL, have been defined. These are collections of best practices that describe activities which have proven themselves as guidelines for the improvement of software processes in organizations.

Organizations use the practice repositories by adopting them or by performing assessments based on them. Moreover, many organizations aim to use multiple practice repositories to benefit from synergy effects and to achieve a higher effectiveness in the software process improvement. However, there are several challenges when using multiple practice repositories. These repositories have to be addressed in a coordinated and systematic way to benefit from them correspondingly.

MOSAIC, a model based approach, is proposed to support the usage of multiple practice repositories and achieve an effective and efficient adoption and assessment based on an integration of these repositories with the software project context. This integration allows various analysis activities to be automatically performed on the integrated models. For this purpose, the structure and terminology of the various practice repositories is normalized, as well as the software project context is modelled by defining situational factors that describe it.

An integration on a common structure and terminology is possible at a conceptual level. The concepts and their similarity relations are extracted from the practice repositories and saved in a central model. This central model relates the various repositories with each other and the repositories with the situational factors and thus, with the software project context. This approach is flexible and allows the integration of practice repositories from different software areas. Therefore, based on the purposes and needs of organizations, the integration can be extended over time into a broader process consideration. Furthermore, specific situational factors that do not describe only the software project settings but also other working contexts can also be added to satisfy specific needs of organizations.

This integration allows various analysis activities on the created models. Consequently, best suited practices from multiple practice repositories can be automatically selected, similar practices and the dependencies between them can be automatically identified. All these analysis activities are based on various metrics that measure the support degree of the practices for the software project context, their similarity and dependency degree respectively.

All these analysis automations can be utilized by organizations when attempting to make key process decisions in their software process improvement. Various applications of MOSAIC for organizations that work with multiple practice repositories are listed and described in this work. Hence, a guidance for software process improvement initiatives of organizations is provided to allow an effective and efficient adoption of such repositories and assessments according to these repositories.

Acknowledgement

A long journey comes to an end. With the support of the family, supervisors, colleagues and friends, I had a remarkable and wonderful journey that gave me the chance to widen my knowledge and wisdom. Therefore, I would like to thank all these people that contributed to this journey.

First of all, I would like to thank Professor Dr. Horst Lichter that continuously provided me constructive feedback and an environment which encouraged me to enjoy my research. Thanks for your patience and your support! I would also like to thank my second supervisor, Professor Luigi Buglione, PhD, for the remarks and suggestions during the last phase of this work.

I am thankful to the many experts from different IT organizations who contributed to the improvement and evaluation of the approach presented in this work. The discussions, interviews or experiments with my former colleagues from Kugler Maag CIE, especially with Dr. Ute Streubel, Frank Sazama and Dr. Klaus Hörmann, enhanced my knowledge in the software process improvement and facilitated the continuous improvement of this approach. Furthermore, I would like to thank two organizations, Generali Deutschland Informatik Services and ITERGO Informationstechnologie that offered me the possibility to gain an insight into the various challenges of organizations working with multiple practice repositories. In particular, Manfred Kricke from Generali Deutschland Informatik Services as well as Burkhard Bujotzek, Martina Funk, Rolf Schmitz and Martina Weber from ITERGO Informations-technologie supported me in this work. Finally, I would like to thank my colleagues from Ireland, especially Professor Dr. Rory O'Connor and Dr. Paul Clarke for providing valuable input for the improvement and evaluation of the approach presented in this work.

Nevertheless, I would like to thank my colleagues from my research department who supported this work and provided me valuable input. They were actively involved in discussions and workshops, listened carefully to my ideas, put the right questions at the right time and provided me suggestions and solutions that led to a more efficient and effective development of my approach. They did not only provide a technical environment where ideas could be discussed and improved, but also a friendly and cooperative atmosphere. I also mention the valuable contribution of my students, especially of Elena Pyatkova, Ana Dragomir and Togrul Mageramov. They worked intensively and achieve promising results for the presented approach during their master theses.

Finally, my family plays an important role for the development of this work as they emotionally supported me during all these last years, praised me in good times and encouraged me in difficult ones. In particular, I would like to thank Nils Jeners, my husband, for his patience and love.

Table of Contents

1	Introduction.....	1
1.1	Usage of Practice Repositories	3
1.2	Experiences with Multiple Practice Repositories	4
1.3	Challenges with Multiple Practice Repositories.....	4
1.3.1	Selection Approaches	6
1.3.2	Identification of Similarities and Dependencies Approaches.....	7
1.4	MOSAIC Approach.....	8
1.5	MOSAIC Challenges, Research Questions and Working Fields.....	9
1.6	Thesis Structure	11
2	Overview	13
2.1	Approach.....	13
2.2	Example Scenario	15
2.3	Analysis Activities and Metrics.....	16
2.3.1	Selection of Practices.....	16
2.3.2	Identification of Similar Practices	17
2.3.3	Identification of Practice Dependencies	21
2.4	Models and Modeling Activities	23
2.4.1	Integration of PRs	24
2.4.2	Integration of Software Project Context with PRs	28
2.5	MOSAIC Toolbox	32
2.6	Analyzer and Modeler Roles	33
2.7	Summary.....	34
3	Meta-Models.....	37
3.1	Integrated Structure Meta-Model	37
3.2	Integrated Concept Meta-Model.....	40
3.3	Situational Factors Meta-Model	43
3.4	Summary.....	47
4	Modeling Activities	49
4.1	Running Example	50
4.2	Structure Normalization.....	50
4.2.1	Extraction of ISM Practice Repositories Elements	51
4.2.2	Extraction of ISM Practice Elements	51
4.2.3	Example	51
4.3	Terminology Normalization	52
4.3.1	Extraction of ICM Concepts based on ISM PracticeConcepts	53
4.3.2	Relation of ICM Concepts to ISM PracticeConcepts	62
4.3.3	Example	62
4.4	Integration of the Software Project Context	66

4.4.1	Extraction of SFM SituationalFactor	66
4.4.2	Relate SFM SituationalFactor to ICM Concepts	66
4.4.3	Example	68
4.5	Summary	70
5	Analysis Activities and Metrics.....	71
5.1	Running Example.....	71
5.2	Measurement Theory	71
5.3	MOSAIC Metrics	72
5.4	Selection of ISM Practices	74
5.4.1	Support Metrics	75
5.4.2	Algorithm	78
5.4.3	Example	79
5.5	Identification of Similar ISM Practices	81
5.5.1	Similarity Theory	81
5.5.2	Identification of the Similarity between ISM Practices	83
5.5.3	Identification of the Coverage between ISM practices	94
5.5.4	Identification of the Output States of ISM Practices	100
5.5.5	Examples	104
5.6	Identification of ISM Practice Dependencies	110
5.6.1	Dependency Metrics	110
5.6.2	Algorithm	112
5.6.3	Example	113
5.7	Summary	116
6	MOSAIC Toolbox	117
6.1	Functional Requirements	117
6.2	Overview of the Tools within the MOSAIC Toolbox	118
6.3	Architecture.....	120
6.3.1	Overview	120
6.3.2	Web Tier	122
6.3.3	Business Tier.....	123
6.3.4	Analysis of the Architecture	124
6.4	Implementation	125
6.4.1	Architecture Conformance	125
6.4.2	Code Metrics	126
6.4.3	GATEModelerTool.....	127
6.5	Summary	137
7	Applications	139
7.1	Overview	140
7.2	Process Profile of an Organization.....	143
7.2.1	MOSAIC Application and Limitations	143
7.3	Value of a Reference PR.....	144
7.3.1	MOSAIC Application and Limitations	145
7.4	New PRs.....	145
7.4.1	MOSAIC Application and Limitations	145

7.5	Tailoring Instrument for Software Projects	146
7.5.1	MOSAIC Application and Limitations.....	146
7.6	Repository of Multiple PRs	147
7.6.1	Examples of Reference PRs for a Repository.....	147
7.6.2	Alternatives for the Construction of a Repository of Multiple PRs	148
7.6.3	MOSAIC Application and Limitations.....	149
7.7	Avoid Redundancies	150
7.7.1	MOSAIC Application and Limitations.....	151
7.8	Avoid Inconsistencies.....	151
7.8.1	MOSAIC Application and Limitations.....	152
7.9	Provide Helpful Information for Adoption.....	152
7.9.1	MOSAIC Application and Limitations.....	153
7.10	Maintenance of Internal Process PRs	153
7.10.1	MOSAIC Application and Limitations.....	154
7.11	Compliance to Reference PRs	154
7.11.1	MOSAIC Application and Limitations.....	155
7.12	Efficient Assessments	155
7.12.1	MOSAIC Application and Limitations.....	155
7.13	Non-redundant and Non-conflicting Requirements.....	156
7.13.1	MOSAIC Application and Limitations.....	156
7.14	Summary.....	156
8	Evaluation.....	161
8.1	Types of Evaluation.....	161
8.2	Subjects Profile.....	163
8.3	Experiments	165
8.3.1	Definition.....	166
8.3.2	Planning	166
8.3.3	Operation and Analysis & Interpretation.....	167
8.3.4	Threats to Validity and Future work.....	168
8.4	Case and Field Studies.....	169
8.4.1	Case Study – Building of MOSAIC models.....	172
8.4.2	Case Study – Mapping between ISM Practices and SFM SituationalFactors	179
8.4.3	Field Study – Software Process Improvement in an Organization.....	185
8.4.4	Conclusion and Summary.....	198
8.5	MOSAIC Toolbox Evaluation.....	198
8.5.1	Effectiveness.....	199
8.5.2	Efficiency.....	202
8.5.3	Satisfaction and Usability.....	203
8.5.4	Summary and Future Work	205
8.6	Summary.....	206
9	Conclusions.....	209
9.1	Contributions	209
9.2	Summary.....	211
10	Appendices.....	215

10.1	MOSAIC Toolbox requirements.....	215
10.1.1	Use Cases for a Modeler	216
10.1.2	Use Cases for the Analyzer	222
10.2	MOSAIC Toolbox Handbook.....	225
10.2.1	Running Example.....	225
10.2.2	Modeler Tools.....	225
10.2.3	Analyzer Tools.....	234
11	Acronyms	241
12	Dictionary	243
13	Bibliography	247