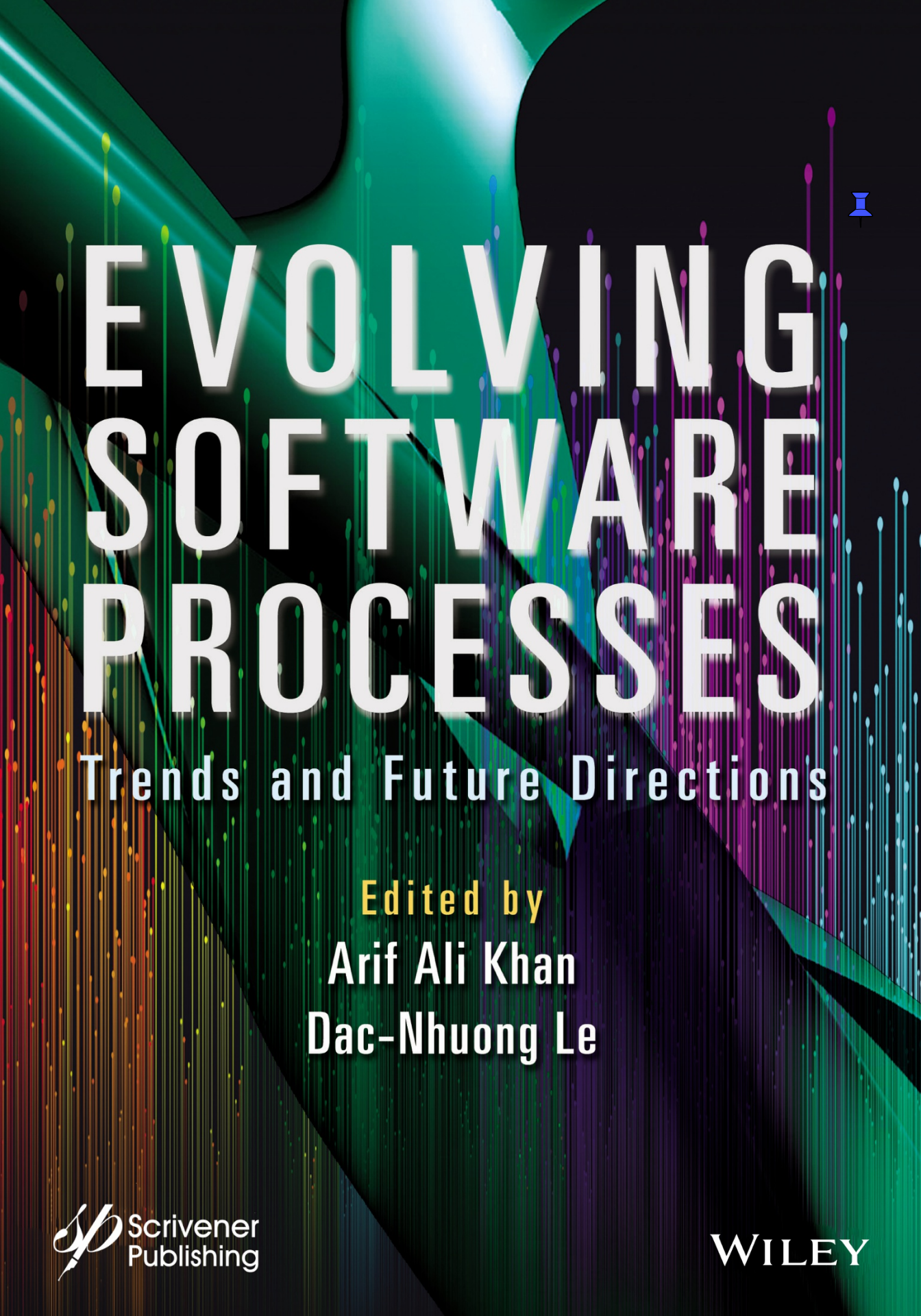




EVOLVING SOFTWARE PROCESSES

Trends and Future Directions

Edited by
Arif Ali Khan
Dac-Nhuong Le

 **Scrivener
Publishing**

WILEY

Evolving Software Processes

Trends and Future Directions

Scrivener Publishing

100 Cummings Center, Suite 541J
Beverly, MA 01915-6106

Publishers at Scrivener

Martin Scrivener (martin@scrivenerpublishing.com)
Phillip Carmical (pcarmical@scrivenerpublishing.com)

Evolving Software Processes

Trends and Future Directions

Edited by

Arif Ali Khan

University of Jyväskylä, Finland

Dac-Nhuong Le

Haiphong University, Haiphong, Vietnam



WILEY

This edition first published 2022 by John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA and Scrivener Publishing LLC, 100 Cummings Center, Suite 541J, Beverly, MA 01915, USA

© 2022 Scrivener Publishing LLC

For more information about Scrivener publications please visit www.scrivenerpublishing.com.

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, except as permitted by law. Advice on how to obtain permission to reuse material from this title is available at <http://www.wiley.com/go/permissions>.

Wiley Global Headquarters

111 River Street, Hoboken, NJ 07030, USA

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Limit of Liability/Disclaimer of Warranty

While the publisher and authors have used their best efforts in preparing this work, they make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of merchant-ability or fitness for a particular purpose. No warranty may be created or extended by sales representatives, written sales materials, or promotional statements for this work. The fact that an organization, website, or product is referred to in this work as a citation and/or potential source of further information does not mean that the publisher and authors endorse the information or services the organization, website, or product may provide or recommendations it may make. This work is sold with the understanding that the publisher is not engaged in rendering professional services. The advice and strategies contained herein may not be suitable for your situation. You should consult with a specialist where appropriate. Neither the publisher nor authors shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages. Further, readers should be aware that websites listed in this work may have changed or disappeared between when this work was written and when it is read.

Library of Congress Cataloging-in-Publication Data

ISBN 978-1-119-82126-7

Cover image: Pixabay.Com

Cover design by Russell Richardson

Set in size of 11pt and Minion Pro by Manila Typesetting Company, Makati, Philippines

Printed in the USA

10 9 8 7 6 5 4 3 2 1

*Dedicated to our friends
and family for their
constant support during the
course of this book*

Contents

List of Figures	xv
List of Tables	xvii
Foreword	xxi
Preface	xxiii
Acknowledgments	xxvii
Acronyms	xxix
1 ReMo: A Recommendation Development Model for Software Process Improvement	1
<i>Sujin Choi, Dae-Kyoo Kim, Sooyong Park</i>	
1.1 Introduction	2
1.2 Motivation	3
1.3 Related Work	5
1.4 Recommendation Development Model: ReMo	7
1.4.1 Correlation Analysis	9
1.4.2 Refining Improvement Packages	14
1.4.3 Building Recommendations	21
1.5 Case Studies	25
1.5.1 Phase I	28
1.5.2 Phase II	28
1.5.3 Phase III	28
1.5.4 Phase IV	29
1.6 Evaluation	29
1.6.1 Process Evaluation	30
1.6.2 Outcome Evaluation	32
1.6.3 Threats to Validity	36
1.7 Discussion	37
1.8 Conclusion	38
References	39
2 A Framework for a Sustainable Software Security Program	47
<i>Monica Iovan, Daniela S. Cruzes, Espen A. Johansen</i>	
2.1 Introduction	48

2.2	Software Security Best Practices	49
2.2.1	Microsoft Security Development Lifecycle for Agile Development	49
2.2.2	Building Security in Maturity Model	50
2.2.3	OWASP Software Assurance Maturity Model	52
2.2.4	Software Security Services	53
2.3	Software Security in Visma	55
2.4	Top-Down and Bottom-Up Approach of a Sustainable Program	55
2.4.1	Ensuring the Adoption and Implementation of Security Practices	56
2.4.2	Enabling the Adoption and Implementation of Security Practices	57
2.4.3	Empowering the Teams	57
2.4.4	Embedding the Security Activities	58
2.5	Explorability of a Sustainable Software Security Program	58
2.5.1	Researching and Innovating Services	58
2.5.2	Creating New Services	60
2.5.3	Persuasion Focusing on the Types of Software Development Teams	61
2.5.4	Service Onboarding	63
2.6	Exploiting Existing Services	63
2.6.1	Collecting Continuous Feedback	64
2.6.2	Retrofitting the Services	65
2.6.3	Focus on Investment Costs and Benefits	66
2.6.4	Discontinuing a Service	66
2.7	Pitfalls of a Sustainable Software Security Program	67
2.8	Further Reading	68
2.9	Conclusion	68
	References	68
3	Linking Software Processes to IT Professionalism Frameworks	71
	<i>Luis Fernández-Sanz, Inés López Baldominos, Vera Pospelova</i>	
3.1	Introduction	72
3.2	Process Standards	74
3.3	IT Professionalism Standards	75
3.3.1	ESCO	76
3.3.2	European e-Competence Framework	76
3.3.3	Skills Match Framework	77
3.4	Linking Software Processes and IT Professionalism Frameworks	78
3.5	Analysis of Recommended Skills in Processes According to Participating Professional Roles	79
3.6	Conclusions	84
	References	84
4	Monitoring and Controlling Software Project Scope Using Agile EVM	89
	<i>Avais Jan, Assad Abbas, Naveed Ahmad</i>	
4.1	Introduction	90
4.2	Related Work	91
4.2.1	Tools and Techniques Used for Scope Definition	92
4.2.2	Traditional Project Scope Definition	93

4.2.3	Tools and Techniques for Agile Project Scope Definition	94
4.3	EVM Applications and Calculation	94
4.4	Research Methodology	96
4.4.1	Systematic Literature Review	97
4.4.2	Mapping of Factors with A-SPSRI Elements	98
4.5	Quantification of A-SPSRI Elements and Running Simulation	101
4.5.1	Quantification of A-SPSRI Elements	101
4.5.2	Running Simulations and Their Integration with Agile EVM	101
4.5.3	Case Study 1	103
4.5.4	Case Study 2	110
4.6	Experimental Evaluation of Simulated Results	112
4.6.1	Regression Model Interpretation	112
4.6.2	Interpretation	113
4.7	Conclusion	114
	References	115
5	Modeling Multi-Release Open Source Software Reliability Growth Process with Generalized Modified Weibull Distribution	123
	<i>Vishal Pradhan, Ajay Kumar, Joydip Dhar</i>	
5.1	Introduction	124
5.2	Background	126
5.3	Proposed Models	127
5.3.1	Model-1 (General Model)	127
5.3.2	Model-2 (Multi-Release Model)	128
5.4	Performance Evaluation with Data Analysis	128
5.4.1	Dataset and Parameter Estimation	128
5.4.2	Competing Models and Comparison Criteria	129
5.4.3	Least Square Estimation (LSE)	129
5.4.4	Goodness of Fit	130
5.4.5	Comparison of Results	130
5.5	Conclusion	131
	References	132
6	Developing a Reference Model for Open Data Capability Maturity Assessment	135
	<i>Murat Tahir Çaldağ, Ebru Gökalp</i>	
6.1	Introduction	136
6.2	Literature Review	137
6.2.1	Theoretical Background	137
6.2.2	Related Works	137
6.3	Model Development	139
6.3.1	Scope	139
6.3.2	Design	139
6.3.3	Populate	140
6.3.4	Test	140
6.3.5	Deploy and Maintain	140
6.4	Open Data Capability Maturity Model	140

6.4.1	Process Dimension	140
6.4.2	Capability Dimension	143
6.5	Conclusion	144
	References	145
7	AHP-Based Prioritization Framework for Software Outsourcing Human Resource Success Factors in Global Software Development	151
	<i>Abdul Wahid Khan, Ghulam Yaseen, Muhammad Imran Khan, Faheem Khan</i>	
7.1	Introduction	152
7.2	Literature Review	153
7.3	Research Methodology	153
7.3.1	Systematic Literature Review	154
7.3.2	Search String Process	154
7.3.3	Search String Development	155
7.3.4	Selection of Publications	155
7.3.5	Commencement of Data Extraction	157
7.3.6	Result Generated for Research Questions through SLR by Applying Final Search String	158
7.3.7	Categorization of Identified Success Factors	159
7.3.8	Analytical Hierarchical Process (AHP)	160
7.4	Proposed Methodology	162
7.4.1	Questionnaire Development	163
7.4.2	Data Sources	163
7.4.3	Validation of Identified Success Factors	163
7.4.4	Application of AHP to Prioritize Success Factors	164
7.4.5	Comparison of Proposed Framework	169
7.5	Limitations	169
7.6	Implications of the Study	169
7.7	Conclusions and Future Work	170
	References	170
8	A Process Framework for the Classification of Security Bug Reports	175
	<i>Shahid Hussain</i>	
8.1	Introduction	176
8.2	Related Work	177
8.2.1	Text Mining for Security Bug Report Prediction	177
8.2.2	Machine Learning Algorithms-Based Prediction	178
8.2.3	Bi-Normal Separation for Feature Selection	178
8.3	Proposed Methodology	178
8.3.1	Data Gathering and Preprocessing	179
8.3.2	Identifying Security-Related Keywords	179
8.3.3	Scoring Keywords	180
8.3.4	Scoring Bug Reports	181
8.4	Experimental Setup	181
8.4.1	Machine Learning Algorithm	181
8.4.2	Dataset	181

8.4.3	Performance Evaluation	181
8.5	Results and Discussion	182
8.5.1	Response to RQ1	182
8.5.2	Response to RQ2	182
8.6	Conclusion	183
	References	183
9	A Systematic Literature Review of Challenges Factors for Implementing DevOps Practices in Software Development Organizations: A Development and Operation Teams Perspective	187
	<i>Mohammad Shameem</i>	
9.1	Introduction	188
9.2	Research Methodology	189
9.2.1	Stage-1: Planning the Review	189
9.2.2	Stage-2: Conducting the Review	191
9.2.3	Stage-3: Reporting the Review Process	191
9.3	Results	192
9.3.1	RQ1 (Challenges Identified in the Literature)	192
9.3.2	RQ2 (Most Critical Challenges)	192
9.3.3	RQ3 (Development and Operation Analysis)	193
9.4	Discussion and Summary	194
9.5	Threats to Validity	194
9.6	Conclusions and Future Study	195
	References	195
10	DevOps' Culture Challenges Model (DC2M): A Systematic Literature Review Protocol	201
	<i>Muhammad Shoaib Khan, Abdul Wahid Khan, Javed Khan</i>	
10.1	Introduction	202
10.2	Background	203
10.3	Systematic Literature Review Protocol	204
10.4	Creating the Search String	205
10.5	Search Strategies	205
10.5.1	Trial Search	205
10.5.2	Recognizing Search Terms Attributes	206
10.5.3	Results for a	206
10.5.4	Results for b	206
10.5.5	Results for c	207
10.5.6	Results for d	207
10.6	Final Search String Construction	208
10.7	Selection Criteria and Search Process	209
10.7.1	Inclusion Criteria	209
10.7.2	Exclusion Criteria	209
10.7.3	Selection of Primary Sources	210
10.8	Assessment of Publication Quality	210
10.9	Data Extraction Stage	210

10.9.1	Initiation of Data Extraction Phase	210
10.9.2	Presentation of Data Extraction	211
10.9.3	Data Extraction Process	211
10.9.4	Data Storage	211
10.10	Data Synthesis	212
10.11	Discussion	212
10.12	Validation of Review Protocol	213
10.13	Limitation	214
	References	214
11	Critical Challenges of Designing Software Architecture for Internet of Things (IoT) Software System	219
	<i>Noor Rehman, Abdul Wahid Khan</i>	
11.1	Introduction	220
11.2	Background	221
11.2.1	Layered Architecture Pattern	222
11.2.2	Microservices Software Architecture	222
11.2.3	Event-Driven Software Architecture Pattern	223
11.2.4	Blackboard Software Architecture Pattern	224
11.2.5	Systematic Literature Review for SADM	224
11.3	Research Questions	224
11.4	Research Methodology	225
11.4.1	Constructing Search Term Formulation	225
11.4.2	Publication Selection Process	229
11.4.3	Quality Assessment of the Publication	230
11.4.4	Data Extraction	230
11.4.5	Data Extraction Demonstration	230
11.4.6	Findings	232
11.5	Continent-Wise Comparison of the Challenges Found	235
11.6	Limitations	235
11.7	Conclusion and Future Work	236
	References	237
12	Challenges to Project Management in Distributed Software Development: A Systematic Literature Review	241
	<i>Sher Badshah</i>	
12.1	Introduction	242
12.2	Related Work	242
12.3	Methodology	243
12.3.1	Planning the Review	244
12.3.2	Conducting the Review	245
12.3.3	Reporting the Review	246
12.4	Results and Discussion	246
12.5	Conclusion and Future Work	248
	References	249

13 Cyber Security Challenges Model: SLR-Based Protocol and Initial Findings	253
<i>Shah Zaib, Abdul Wahid Khan, Iqbal Qasim</i>	
13.1 Introduction	254
13.2 Related Work	254
13.3 Systematic Literature Review (SLR) Protocol	256
13.4 Research Questions	256
13.5 Search Term Construction	256
13.6 Strategies for Searching	257
13.6.1 Trial Searching	257
13.6.2 Characteristics of Search Terms	257
13.7 Process of Search String	258
13.7.1 Development of Search String	258
13.7.2 Resources to be Searched	259
13.8 Selection of Publication	259
13.8.1 Inclusion Criteria	259
13.8.2 Exclusion Criteria	260
13.8.3 Support of Secondary Reviewer	260
13.9 Assessment of Publication Quality	260
13.10 Data Extraction Phase	261
13.10.1 Commencement of Data Extraction Phase	261
13.10.2 Presentation of Extracted Data	261
13.10.3 Data Extraction Process	261
13.10.4 Data Storage	262
13.11 Literature Search and Selection	262
13.12 Results	263
13.12.1 Challenges in CSCM Based on Database/Digital Libraries	263
13.12.2 Challenges in CSCM Based on Methodology	265
13.13 Discussion	266
13.14 Limitations	266
13.15 Conclusion and Future Work	266
References	267
14 A Process Assessment Model for Human Resource Skill Development Enabling Digital Transformation	271
<i>Ebru Gökalp</i>	
14.1 Introduction	272
14.2 Literature Review	273
14.2.1 Human Resource Skill Development	273
14.2.2 Theoretical Background	273
14.3 Process Assessment Model for Human Resource Skill Development	274
14.3.1 Process Dimension	274
14.3.2 Capability Dimension	274
14.4 Application of the Process Assessment Model for DX-HRSD	276
14.5 Findings and Discussions	277
14.6 Conclusion	279
References	279

List of Figures

1.1	Process of improvement process.	3
1.2	Summary of recommendation review results.	5
1.3	ReMo.	8
1.4	Correlation analysis.	9
1.5	Correlated tasks via work products.	10
1.6	Identifying finding correlations.	11
1.7	Finding correlations.	12
1.8	Identifying improvement packages.	13
1.9	Improvement package description.	14
1.10	Refining improvement packages.	14
1.11	Findings-to-organization matrix.	15
1.12	Findings from organizational view.	17
1.13	Finding-to-life cycle matrix.	17
1.14	Findings from software life cycle view.	18
1.15	Capability-based process model guidance.	18
1.16	Finding from assessment model view.	19
1.17	Finding-to-business value matrix.	20
1.18	Findings from business value view.	20
1.19	Building recommendations.	21
1.20	Abstract recommendation.	21
1.21	Identifying recommendation seeds.	23
1.22	Concrete recommendation.	24
1.23	Evolution of ReMo.	28
1.24	Concreteness comparison – Process element coverage.	33
1.25	Concreteness comparison per project.	34
1.26	Concreteness comparison of recommendation examples.	34
1.27	Comprehensiveness comparison – Process area coverage.	35
1.28	Comprehensiveness comparison – Recommendation example.	36
2.1	The ambidextrous security program.	56
2.2	Percentage of people in each adopter category.	61
3.1	Non-cognitive skills framework represented as clusters.	78
4.1	Research methodology.	97
4.2	Evaluation results.	101
4.3	Projections of percentiles for score and cost (F. Acebes [62]).	102
4.4	AON network diagram.	106
4.5	Sample burn-up chart showing schedule variance.	108

4.6	Burn-down chart reflecting scope change and schedule variance.	108
4.7	Projection of i^{th} iteration into different percentiles.	109
4.8	Burn-up chart incorporating cost.	110
4.9	Projection into score and cost.	112
4.10	Projection into score and cost.	113
4.11	Multiple releases.	113
4.12	Features at single release.	114
4.13	Projection into score and cost.	114
5.1	Workflow diagram.	125
5.2	(a-i) Fitted shapes and residuals of GO, G-GO, and GMWD models on Beam 2.0.0, 2.1.0, and 2.2.0 failure datasets.	132
6.1	The capability dimension of the OD-CMM (adapted from [49]).	144
7.1	Division of complex problem into a hierarchical structure.	160
7.2	Schematic diagram of proposed research design of the analytic hierarchy process (AHP) consistency ratio.	162
7.3	Hierarchical structure of the present study for the analytic hierarchy process (AHP) method.	165
8.1	Proposed system model.	179
8.2	Performance evaluation of datasets using precision, recall and F-measure.	182
8.3	Change in recall.	183
9.1	Reporting the review process.	191
11.1	Layered architecture.	222
11.2	Graphical representation of microservices architecture pattern.	223
11.3	Event-driven architecture pattern.	223
11.4	Graphical representation of blackboard software architecture.	224
11.5	Graphical representation of the identified challenges.	235
13.1	Searching and selection process of research articles.	262
14.1	The measurement framework (adapted from ISO/IEC 330xx).	274

List of Tables

1.1	Recommendation examples in current practice.	4
1.2	Reviewed projects.	4
1.3	Example findings of assessment.	9
1.4	Recommendation description templates.	22
1.5	Companies that participated in case studies.	25
1.6	Assessment data used in case studies.	26
1.7	Participants in case studies.	27
1.8	Case study summary.	27
1.9	Measurement items for PU and PEOU.	30
1.10	Survey results on PU.	30
1.11	Survey results on PEOU.	31
1.12	Mann-Whitney U Test results on PU and PEOU.	32
1.13	Example recommendations produced by an ad-hoc method in current practice.	33
1.14	Process element coverage.	33
1.15	Process area coverage per project.	35
1.16	A comparison of ReMo with existing studies.	38
1.17	Example results in case studies.	44
1.18	Example results in case studies (continued).	45
1.19	Example results in case studies (continued).	46
3.1	Profile equivalence in e-CF, ESCO and Colomo's study.	79
3.2	Profiles involved in ISO 12207 processes.	79
3.3	Skills relevance in ISO 12207 processes.	80
3.4	Link from NCSF to processes in ISO 12207.	81
3.5	Link from processes to e-CF competences through deliverables.	82
4.1	Combination of different approaches used as monitoring and controlling methods in software project management.	92
4.2	Tools/techniques used for traditional project scope definition.	93
4.3	Tools/techniques used for agile project scope definition.	93
4.4	Extracted factors from the literature.	98
4.5	Mapping of factors elements.	99
4.6	Descriptive statistics.	100
4.7	Description of notations.	105
4.8	A-SPSRI elements.	106
4.9	Top contributing A-SPSRI elements.	107
4.10	Top 8 contributing A-SPSRI elements.	107
4.11	Assign definition level.	110

4.12	Weight, dl and score of elements in Case Study 2.	111
4.13	Assign cost to A-SPSRI elements.	112
5.1	Acronyms and notations.	125
5.2	Special cases of GMWD function with different values of parameters.	127
5.3	Dataset: Beam 2.0.0, Beam 2.1.0, and Beam 2.2.0.	129
5.4	Competing and proposed models with MVE.	129
5.5	Competing and proposed models with MVE.	131
6.1	Quality assessment criteria.	138
6.2	Existing MMs assessment results.	138
6.3	The process dimension of the OD-CMM.	142
6.4	Capability levels.	144
6.5	Existing maturity models in the open data domain.	149
6.6	An example process definition of ODM2 open data discovery process.	150
7.1	Search outcomes of different resources/libraries and databases.	155
7.2	Details of extracted data.	157
7.3	Synthesis of details of success factors.	159
7.4	Success factors for software outsourcing human resource.	160
7.5	Description of 9-point scale for intensity of importance.	161
7.6	Relationship between size of matrix and random consistency index.	162
7.7	Success factors identified in the questionnaire study.	164
7.8	Pairwise comparison matrix between the success factors of the “procurement” category.	165
7.9	Synthesized or normalized matrix of the “procurement” category.	165
7.10	Pairwise comparison matrix between the success factors of the “organization” category.	166
7.11	Synthesized or normalized matrix of the “organization” category.	166
7.12	Pairwise comparison matrix between the success factors of the “reliance” category.	166
7.13	Synthesized or normalized matrix of the “reliance” category.	166
7.14	Pairwise comparison matrix between the success factors of the “reliance” category.	167
7.15	Synthesized or normalized matrix of the “quality” category.	167
7.16	Pairwise comparison matrix between the categories of success factors.	167
7.17	Synthesized or normalized matrixes of the categories of success factors.	167
7.18	Summary of local and global weights issues and their rankings.	168
7.19	Prioritizing the success factors.	169
9.1	Search strings and digital libraries.	190
9.2	Inclusion and exclusion criteria	190
9.3	Quality evaluation criteria.	190
9.4	Search process.	191
9.5	Identified challenges.	192
9.6	Categorization of the challenges based on development and operations teams.	193
9.7	Selected primary studies.	198
9.8	DevOps practitioners.	199
10.1	Search string construction.	205
10.2	RQ1 search terms construction.	205

10.3 RQ2 search terms construction.	205
10.4 RQ3 search terms construction.	205
10.5 Detail of search results of different databases.	208
10.6 Detail of primary selected papers.	209
10.7 Data extraction format.	211
10.8 List of critical challenges.	212
11.1 Search term construction composition.	225
11.2 RQ1 search terms construction.	226
11.3 RQ2 search terms construction.	226
11.4 RQ3 search terms construction	226
11.5 Final search results.	228
11.6 Snowballing technique results.	228
11.7 Data demo table.	230
11.8 Frequency-wise list of challenges.	231
11.9 Results of data from different continents.	236
11.10Continent-wise frequency.	237
12.1 SLR process.	244
12.2 Quality assessment.	245
12.3 Selection of studies using tollgate approach.	246
12.4 Project management challenges identified from selected primary studies.	247
12.5 Project management knowledge areas, GSD challenges and PM implications in GSD.	248
13.1 General format of the construction of a search term.	256
13.2 RQ1 search term construction.	256
13.3 RQ2 search term construction.	257
13.4 Search results of different resources.	259
13.5 Primary and final selected papers results.	259
13.6 Data extraction presentation.	261
13.7 List of challenges in CSCM identified through SLR.	263
13.8 Database/digital library-wise list of challenges.	264
13.9 Methodology-wise list of challenges.	265
14.1 The process definition of DX-HRSD.	275
14.2 Scale definitions.	276
14.3 Process capability level ratings (adapted from ISO/IEC 33002).	276
14.4 Capability Level 1 assessment of DX-HRSD process.	278
14.5 Capability level assessment of DX-HRSD process.	278

Foreword

A number of books have been written over the years about improving the software process, some of them quite good, some less so. Arif and Dac-Nhuong Le have edited a book that I will be happy to add to my library. They have been involved in software process assessment and improvement for years, so they have the experience necessary to speak knowledgeably about the topic. They have included interesting chapters in this book that I think are important for systematic process improvement and management in today's industrial evolution.

The development processes in the software industry continue to evolve tremendously and it takes innovative efforts to cope with the global challenges. For instance, the present COVID-19 pandemic situation is reshaping the software industry working environment and is driving continuous changes in the software engineering processes, methods and collaborative software development environment. Industry will see the long-term effects in the coming years. It is a struggle to reform the working environment and specifically the software processes that are seriously affected by the 2019 pandemic.

One might argue that there are already many books that include descriptions of software processes. The answer is “yes, but.” Becoming acquainted with existing software processes is not enough. It is tremendously important to understand the evolution and advancement in software processes so that they appropriately address the problems, applications, and environments to which they are applied. Providing basic knowledge for these important tasks is the main goal of this book.

Industry is in search of software process management capabilities. The emergence of the COVID-19 pandemic emphasizes the industry's need for software with specific process management capabilities. Most of today's products and services are based to a significant degree on software and are the result of large-scale development programs. The success of such programs heavily depends on process management capabilities, because

they typically require the coordination of hundreds or thousands of developers across different disciplines. Additionally, software and system development is usually distributed across geographical, cultural and temporal boundaries, which make the process management activities more challenging in the current pandemic situation. It is vital for software development organizations to address the quality challenges by improving the organizational practices and processes. A mature software process can assist an organization in successfully executing software development activities.

This book provides the basic building blocks used in the evolution of software processes, such as DevOps, agile processes management, process assessment for human resources, recommendation models for process improvement and security, in order to lay a solid foundation for successful and sustainable future processes.

I would like to congratulate the editors of this volume, Arif Ali Khan and Dac-Nhuong Le, for compiling such timely and comprehensive research contributions. The diversity of topics covered by different chapters and the profiles of contributing authors, who are internationally established researchers, is very impressive. Different chapters describe cutting edge research efforts that try to get to the depth of many of the abovementioned challenges, with an overall aim of providing a detailed literature review, starting from fundamental concepts to more specific technologies and application use cases. I firmly believe that this edited book will provide a comprehensive resource to students, researchers, and practitioners, and have a long-lasting positive impact on this important and growing research and technological field.

Pekka Abrahamsson, PhD

Professor of Information Systems Science,
Empirical Cyber Security and Software Engineering,
University of Jyväskylä, Finland
September 2021

Preface

The extremely comprehensive overview of the evolution in software processes given in this book makes it very valuable for a wide audience of interested readers. This book specifically provides a platform for practitioners, students and researchers to discuss the studies used for managing aspects of the software process, including managerial, organizational, economical and technical. It provides an opportunity to present empirical evidence using available managerial, organizational, economical and technical strategies of software processes, as well as proposes new techniques, tools, frameworks and approaches to maximize the significance of software process management.

The following studies are discussed in the 14 chapters of this book.

- In Chapter 1, Sujin Choia, Dae-Kyoo Kimc, and Sooyong Park propose a novel recommendation model (i.e., ReMo), which to enables systematic development of quality recommendations through rigorous analysis of assessment findings.
- In Chapter 2, Monica Iovan, Daniela S. Cruzes, and Espen A. Johansen describe the practical solutions in one systematic model for purposely disseminating innovations in software security practices through careful attention to the stages of effective and sustainable implementation of the software security program. The goal of the proposed framework is to enable software organizations to create a sustainable security program that ensures that software teams continue to use the practices that improve and address the security of the products, hence adopting a long-term perspective.
- In Chapter 3, Luis Fernández-Sanz, Inés López Baldominos and Vera Pospelova develop the bridge between software processes and IT professionalism frameworks. They discuss the missing relationships between processes and activities in software development projects, the job profiles involved in them, and the skills recommended for effective performance.
- In Chapter 4, Avais Jan *et al.* incorporate earned value management (EVM) into agile software development. They propose a novel framework to tackle the key EVM challenges in agile environment.
- In Chapter 5, Vishal Pradhan, Ajay Kumar and Joydip Dhar propose a process model to understand the reliability of open source software (OSS) system releases. The effectiveness of the proposed model is assessed based on the experimental results, which revealed that it is an efficient reliability model for multi-release OSS.

- In Chapter 6, Murat Tahir Çaldağ and Ebru Gökalp present an open data capability maturity model (OD-CMM) they developed to evaluate the open data capabilities of an organization and provide a road map for further improvements. The model is developed based on the concepts of ISO 330xx family of standards.
- In Chapter 7, Abdul Wahid Khan *et al.* present a systematic literature review (SLR) and industrial survey study, which they conducted to develop a conceptual map of the success factors that could impact the outsourcing of human resources in the domain of global software development (GSD). A total of thirteen success factors are identified, which are further classified across four main categories.
- In Chapter 8, Shahid Hussain proposes a process framework to address the classification problem of security and non-security bug reports. The framework identifies the important security-related keywords from the security bug reports (SBR) and removes these keywords from the non-security bug reports (NSBR) to improve classification decisions. The framework is empirically evaluated and the results indicate its significance in terms of classification of the SBRs.
- In Chapter 9, Mohammad Shameem presents an SLR study he conducted to identify the challenging factors that could negatively impact the DevOps practices in software development organizations. The SLR study revealed a total of 16 challenging factors, which were further analyzed to reveal the most significant factors. Finally, the identified factors were analyzed across the development and operation silos of DevOps practices.
- In Chapter 10, Muhammad Shoaib Khan, Abdul Wahid Khan and Javed Khan present an SLR protocol to identify the cultural challenges in the DevOps environment. The ultimate goal of the study was to develop a DevOps culture challenges model (DC2M) to improve communication, coordination, understanding, and trust, and to reduce the barriers between development and operation silos.
- In Chapter 11, Noor Rehman and Abdul Wahid Khan report on the barriers of IoT-based software architecture. The SLR approach was used to explore the available primary studies and a total of 20 barriers were identified, which were further analyzed based on different continents.
- In Chapter 12, Sher Badshah addresses the project management challenges in the GSD environment. The study's findings consist of a total of 25 challenges that could be potential barriers for project management activities in GSD. Finally, the identified challenges are mapped into the knowledge areas of the project management body of knowledge (PMBOK) framework.
- In Chapter 13, Shah Zaib, Abdul Wahid Khan and Iqbal Qasim discuss cybersecurity challenges. The SLR approach was adopted and identified a total of 13 challenging factors. The challenging factors were also analyzed based on the digital repositories of the primary studies and the adopted research methods.
- In Chapter 14, Ebru Gökalp presents the capability maturity model he developed to improve the digital transformation (DX) human resource skill development process in an organization. The proposed model is based on the

concepts of ISO 330xx family of standards. The industrial evaluation of the model shows that the proposed approach is applicable to assess the current DX human resource skill development capability level of an organization and provide best practices to move to the next maturity level.

Since it disseminates cutting-edge research that delivers insights into the tools, opportunities, novel strategies, techniques, and challenges for managing software processes, this book will be a useful resource for practitioners, students and researchers alike.

Practitioners and executives will learn what impact the evolving software processes can have on their projects. They will see ways in which the frequent and continuous change in today's software processes can help to develop software that is faster and more flexible with regard to customer needs. Those practitioners who need to react to the changing requirements by adapting the concepts of continuous development and integration, will read about how DevOps, agile and global software development practices help to live up to these new challenges. This book gives an overview of which methods are used today and how to apply them to a specific project, and includes practices to plan and monitor projects.

Students could benefit from the book by gaining an understanding of the recent trends in software process management. Moreover, it could be used in software engineering degree courses, specifically systematic literature review studies in software process improvement, agile software development, global software development processes, process models, and software project management.

Researchers getting involved with the advanced software processes will find a profound introduction to the subject. They will rapidly become acquainted with these new concepts and understand how these new trends could be used in future research projects.

Arif Ali Khan
Dac-Nhuong Le
October 2021

Acknowledgments

First of all, we would like to thank all our colleagues and friends for sharing our happiness at the start of this project and following up with their encouragement when it seemed too difficult to complete. We are thankful to all the members of Scrivener Publishing, especially Martin Scrivener and Phillip Carmical, for giving us the opportunity to write this book.

We would like to acknowledge and thank the most important people in our lives, our parents and partners, for their support. This book has been a long-cherished dream which would not have been turned into reality without the support and love of these amazing people, who encouraged us with their time and attention. We are also grateful to our best friends for their blessings and unconditional love, patience, and encouragement.

Arif Ali Khan
Dac-Nhuong Le

