

Contents

1	INTRODUCTION	1
1.1	Problem Description	2
1.2	Research Goals and Contribution	7
1.3	Structure of the Thesis	9
2	BUSINESS PROCESSES AND WORKFLOW MODELING	11
2.1	Modeling Languages	13
2.1.1	Perspectives of Business Processes and Workflows	13
2.1.2	Requirements for Business Process Modeling Languages	14
2.2	Petri Nets	16
2.3	Event-Driven Process Chains (EPCs)	18
2.4	UML Activities	20
2.5	Summary	27
3	QUALITY OF BUSINESS PROCESSES	29
3.1	Quality in General	29
3.2	Total Quality Management	30
3.3	Structural Quality Aspects of Process Models	31
3.4	Patterns and Model Quality	34
3.5	Workflow Patterns	39
3.6	Patterns and Temporal Logic	41
3.7	Design Patterns and Behavior	42
3.8	Business Rules and Flexible Processes	44

3.9	Resulting Requirements	46
3.10	Summary	48
4	A SEMANTIC MODEL FOR UML ACTIVITIES	51
4.1	Requirements for a Semantic Model	52
4.1.1	Coverage	53
4.1.2	Expressive Power of the Formalism	53
4.1.3	Precision of the Formalization	53
4.1.4	Capability of Automated Execution	54
4.2	An Overview of Existing Approaches	54
4.3	The Dynamic Meta Modeling (DMM) approach	56
4.3.1	Meta Relations	56
4.3.2	Graph Transformations	60
4.3.3	Execution of Graph Transformation Systems	66
4.4	Application of DMM	69
4.5	Properties of the Resulting Transition System and Limitations	73
4.5.1	Distinguished Transitions	73
4.5.2	Traverse-to-Completion	73
4.5.3	Non-local Behavior	76
4.5.4	Concurrency	77
4.5.5	Analyzability of Business Processes and Limitations	78
4.6	Summary	79
5	BUSINESS PROCESS PATTERNS	81
5.1	Language Requirements for the Design of the PPSL	84
5.1.1	General Requirements for the PPSL	84
5.1.2	Language Requirements Resulting from Typical Process Constraints in Quality Management	86
5.2	The Design of the PPSL	90

5.2.1	Actions and Action Prototypes	91
5.2.2	Action Cardinalities	93
5.2.3	Temporal Relationships	94
5.2.4	Logical Relationships	100
5.2.5	Summary of the Design of the PPSL	104
5.3	Abstract Syntax of the PPSL	104
5.3.1	Meta Model of the PPSL	105
5.3.2	Well-formedness Rules	107
5.4	Summary	111
6	FORMAL VERIFICATION BASED ON BUSINESS PROCESS PATTERNS	113
6.1	Adaptation of the Execution Semantics Description of Business Processes	115
6.1.1	Requirements for Adapting the LTS	116
6.1.2	Development of a Reduction Algorithm	118
6.1.3	Conclusion	128
6.2	Translation of Pattern Diagrams into Temporal Logic	129
6.2.1	Temporal Logic	129
6.2.2	Overview of the Translation	133
6.2.3	Formal Specification of the PPSL	134
6.2.4	Example	147
6.3	Performing the Formal Verification	149
7	SUPPORT FOR PATTERN-BASED PROCESS MODELING	151
7.1	Pattern-based Modeling of Business Processes	151
7.2	Requirements for the PBPM Workbench	154
7.3	Use Cases of the PBPM Workbench	156
7.4	Design of the Prototype	157
7.4.1	Realization as Eclipse Plug-In	160

7.4.2	Integration of External Tools	161
7.5	Application of the Workbench	162
7.5.1	Defining and Editing Business Processes and Patterns	163
7.5.2	Defining and Editing the Action Mapping	164
7.5.3	Performing the Verification	167
7.5.4	Back Annotation of the Verification Result	168
7.5.5	Debugging/Evaluation Views	170
7.6	Summary and Discussion	170
8	CASE STUDY	173
8.1	Business Processes for Wholesale Financing	174
8.2	Principles and Patterns of Wholesale Financing	178
8.3	Assessment of Business Processes	180
8.4	Further Empirical Data from the Case Study	192
8.5	Conclusion	194
9	CONCLUSION	195
9.1	Summary and Conclusion	195
9.2	Outlook and Future Work	197
	REFERENCES	201