

Table of Contents

Table of Contents	I
List of Figures	IV
List of Tables	VI
List of Abbreviations	VII
1 Introduction.....	1
1.1 Motivation	1
1.2 Structure of the Thesis	12
2 Fundamentals & Problem Statement	15
2.1 Production Systems.....	15
2.2 Production Planning and Control	17
2.3 Production Planning and Control System Structures.....	24
2.4 Modelling of Production Planning Problems and their Coordination	27
2.5 Digitalisation & Industry 4.0.....	34
2.6 Complexity of Production Systems	52
2.7 Enterprise Architecture Management	55
3 Research Artefacts and Design.....	59
3.1 Research Artefacts.....	59
3.2 Research Design	66
4 Predicting the Computational Complexity of Production Planning Problems ...	79
4.1 Development of Machine-Learning Testbed.....	79
4.1.1 Machine-learning Algorithms	82
4.1.2 Feature Selection	84
4.1.3 Experimental Results	87
4.2 Development of Causality Graph	92
4.2.1 Determination of Classes of Homogenous Model Elements and Extensions	94
4.2.1.1 General Analysis	95
4.2.1.2 Planning Model Analysis	99
4.2.1.3 Determination of Impact on Computational Complexity	102
4.2.1.4 Deriving Classes of Thematically Homogenous Model Elements and Extensions	104
4.2.2 Identification of Relevant Complexity Drivers.....	106
4.2.2.1 Literature Research Methodology for the Identification of Complexity Drivers	107
4.2.2.2 Identified Complexity Drivers	110
4.2.2.3 Interdependencies between Identified Complexity Drivers and Computational Complexity of Production Planning Problems	121

4.2.2.4	Linking to Qualitative External Complexity Drivers	124
4.2.2.5	Qualitative Complexity Assessment Process	126
4.3	Evaluation of Complexity Assessment Methodology.....	129
4.3.1	Analytical Assessment.....	131
4.3.2	Expert Interviews for Qualitative Complexity Assessment	134
5	Identification and Selection of Heterarchical PPC Architectures	137
5.1	Classification of Heterarchical PPC Architectures	138
5.1.1	Requirements for the Taxonomy of Heterarchical PPC Architectures.....	140
5.1.2	Heterarchical PPC Architectures in Literature	141
5.1.3	Development of a Taxonomy for Heterarchical PPC Architectures ...	148
5.2	Aligning Heterarchical PPC Architecture Requirements with Legacy Production Systems	162
5.2.1	Overview of ArchiMate Modelling Language	163
5.2.2	Analysis of ArchiMate Modelling Language	166
5.2.2.1	Assessment and Adaptation Methodology.....	168
5.2.2.2	Application of Assessment and Adaptation Methodology ...	171
5.3	Expert Interviews Regarding Classification and Modelling of Heterarchical PPC Architectures	193
6	Support and Guidance for Heterarchical PPC Architecture Implementation Projects.....	199
6.1	Literature Survey on MES Implementation Methodologies	201
6.1.1	MES Implementation Methodologies.....	202
6.1.2	EAM-based Implementation Methodologies	206
6.2	Requirement Elicitation through Semi-Structured Interviews of Solution Providers.....	215
6.3	Implementation Methodology for Heterarchical PPC Architectures.....	217
6.4	Expert Interviews Regarding Implementation Methodology Assessment	227
7	Case-based Evaluation	231
7.1	Case A: Automotive Supplier	233
7.2	Case B – Aviation Supplier	240
7.3	Case C- Industry 4.0 Demonstrator	246
7.4	Discussion	250
8	Conclusion	253
8.1	Summary.....	253
8.2	Limitations	256
8.3	Outlook	258

References	261
Appendix	297
A. Identified Complexity Drivers	297
B. Assignment of Architectures to Characteristics	301
C. Identified Architectural Element Relationships	307
D. Ontological Mapping of Architectural Elements to ArchiMate	308