

Table of Content

Acknowledgment..... i

Abstrakt..... ii

Abstract..... iii

Table of Content..... iv

Abbreviations and Symbols..... vii

List of Figures..... xi

List of Tables..... xv

1 Introduction..... 1

1.1 Overview 2

1.2 Motivation..... 8

1.3 Research Questions and Objectives 11

1.4 Dissertation Navigator 13

2 Fundaments in Logistics/Production System 15

2.1 Current Production Planning and Control 16

2.2 Logistics and Supply Chain Management 27

2.3 Dynamics and Autonomy in Logistics 31

2.3.1 Dynamics in Logistics..... 31

2.3.2 Centralized, Decentralized, and Autonomous Control Systems 34

2.3.3 Autonomous Logistic System..... 38

2.3.4 Autonomous Logistic Objects..... 42

2.3.5 Supply Chain and Production Structures..... 44

2.3.6 Shop-Floor Scheduling..... 50

3 Conventional Compatible Techniques (Research Approach) 63

3.1 Closed and Open System Review Towards Learning..... 64

3.2 Closed-Loop System vs. Complexity in SC Review..... 67

3.3 Material Flow Review 72

3.3.1 Material Push 72

3.3.2 Material Pull 73

3.4 Kanban 74

3.5 Conwip 77

3.6 Polca..... 79

4 Introduction of Learning Pallets and Applied Methods 82

4.1 Learning Pallets (Lpallets)..... 83

4.2 Artificial Intelligence..... 91

4.2.1	Genetic Algorithm	92
4.2.2	Simulated Annealing	99
4.2.3	Tabu Search	101
4.2.4	Fuzzy System	102
4.2.5	Artificial Neural Networks	113
4.2.6	Multilayer Perceptron and Backpropagation Learning	119
4.2.7	Radial Basis Function Networks	122
4.3	Simulation	128
4.4	Mathematical Programming/Optimization	130
4.5	Queuing Theory	137
4.5.1	Arrival and Service Process	139
4.5.2	Open Queuing Network	145
4.5.3	Closed Queuing Network	147
4.5.4	Contribution of the queuing theory to Lpallets	151
5	Experiment Scenarios with Simulation	153
5.1	Integration of Lean-Agile Experiments with Autonomy in Supply Chains	154
5.1.1	Introduction of the Experiment	154
5.1.2	Agile Logistics	155
5.1.3	Autonomous Control System in Logistics	156
5.1.4	Logistics Performance Measures	156
5.1.5	Push vs. Pull System	156
5.1.6	Simulated Scenario	158
5.1.7	Simulation Run and Results	159
5.1.8	Conclusion of the Experiment	162
5.2	Optimization of Material-Pull in a Push-Pull Flow Logistic Network, using Meta-Heuristic and Fuzzy System	163
5.2.1	Hybrid Push-Pull Control	164
5.2.2	Problem Definition	165
5.2.3	Applied Genetic Algorithm	166
5.2.4	Simulated Annealing	167
5.2.5	Fuzzy Set	168
5.2.6	Experiment Results	169
5.3	Toward Learning Autonomous Pallets by Using Fuzzy Rules, Applied in a Conwip System	172
5.3.1	Mathematical Programming Representation	173
5.3.2	Lpallets in Pull System	175

5.3.3	Simulation Results Analysis.....	179
5.3.4	Experiment Summary	186
5.4	Application of Learning Pallets in Hybrid Flow-Open Shop Scheduling Using Artificial Intelligence	187
5.4.1	Hybrid Flow-Open Shop Problem	188
5.4.2	Assembly Scenario.....	189
5.4.3	Lpallets in the Scenario.....	190
5.4.4	Application of GA.....	191
5.4.5	Application of Fuzzy Inference System	191
5.5	Application of Radial Basis Function Network.....	192
5.5.1	Simulation Results	193
5.5.2	Analysis by Closed Queuing Network.....	194
5.5.3	Extended RBF Network.....	197
5.5.4	Extended Scenario and Results	198
5.5.5	Conclusion of the Experiment.....	200
6	Physical Implementation of Prototype.....	202
7	Conclusion and Outlook.....	208
7.1	Conclusion	209
7.2	Outlook.....	211
	References.....	215
	Appendix A.....	236
	Appendix B.....	242