
Contents

1	Introduction	1
1.1	Intermodal transportation	2
1.1.1	Consolidation-based transportation	4
1.1.2	Empty flows	5
1.1.3	Planning levels of operations	5
1.1.4	Joint initiatives	6
1.2	Scope of the thesis and research questions	6
1.3	Research methodology	8
1.4	Contribution of the thesis	9
1.5	Structure of the thesis	12
2	Coordination and Analysis of Container Barge Networks	13
2.1	Introduction	13
2.2	Literature review	15
2.3	Description of the problem	16
2.4	Direct shipment policy	18
2.5	The tour shipment policy	24
2.6	Comparison of direct and tour shipment policies	30
2.7	Study of direct and tour shipment policies for ring and line topologies	31
2.7.1	Ring network topology	31
2.7.2	Line network topology	36
2.8	Numerical study	38
2.9	Conclusions	44
3	SSND with Design-Balance and Synchronization Constraints	47
3.1	Introduction	47
3.2	Literature review	51
3.3	Problem statement	52
3.4	Problem description	53
3.5	Mathematical model	56
3.5.1	A simple four-node example	63
3.6	Model Validation	65
3.7	Experimental Results	68
3.7.1	Instance generation	68
3.7.2	Computational results	70
3.8	Conclusions	72
3.9	Appendix A	74

4 A Metaheuristic for SSND Problems	81
4.1 Introduction	81
4.2 Problem formulation	83
4.2.1 Structure of the solution of the model	86
4.3 Solution method	86
4.3.1 Construction of an initial feasible solution	91
4.3.2 Search space and neighborhood structure	93
4.3.3 Neighborhood problem formulation	94
4.3.4 Mathematical formulation of neighborhood problems . .	108
4.3.5 Learning schemes and memory lists	112
4.3.6 Intensification and diversification search phases	113
4.3.7 Post-optimization search phase	115
4.4 Computational experiments	115
4.4.1 Benchmark of the proposed search procedure	116
4.5 Conclusions	119
4.6 Appendix B	123
5 Empty Container Repositioning Games	125
5.1 Introduction	125
5.2 Preliminaries	128
5.2.1 Graphs and linear programming	128
5.2.2 Cooperative game theory	129
5.3 Modeling approach and game definition	131
5.4 ILP and its linear relaxation	144
5.5 Core of ECR-games	148
5.6 Allocation rules for ECR-situations and their properties	151
5.7 Conclusions	167
5.8 Appendix C	169
6 Conclusions	171
6.1 Summary of results	172
6.2 Discussion and future research	174
Summary	185
About the author	189