
Table of Contents

Resumen	v
Resum	vii
Abstract	ix
Acknowledgements	xi
List of Figures	xvii
List of Tables	xxi
List of Abbreviations	xxv
1 Introduction, motivation and objectives	1
1.1 Motivation of the research	1
1.1.1 A wooden ship trade age	1
1.1.2 Contemporary international maritime trade	2
1.1.3 A containerized world	4
1.1.4 Sustainable development goals for the future	5
1.2 Container terminal	7
1.2.1 Container terminal equipment	7
1.2.2 Container terminal layouts	9
1.2.3 Container terminal and operations research	12
1.3 Objectives of the thesis	15
1.3.1 General objectives	15
1.3.2 Specific objectives	16
1.4 Outline of the thesis	17

2	Literature review	21
2.1	General review on scheduling problems	21
2.2	Review on related problems in yard terminals	22
2.3	Review on yard crane scheduling problems	23
2.3.1	Basic settings of yard crane scheduling problems	25
2.3.2	Multiple and combined yard crane scheduling problems	26
2.3.3	Single yard crane scheduling problems	26
2.3.4	Solution methods for yard crane scheduling problems	28
3	The yard crane scheduling problem	31
3.1	Configurations and assumptions for the terminal yard	31
3.2	Types of container in the yard block	33
3.3	Decision making and objective formulation for the yard crane scheduling problem	37
3.4	Nomenclature	40
3.5	Mathematical model for the yard crane scheduling problem	41
4	Constructive heuristic methods	47
4.1	Introduction	47
4.2	Solution representation	48
4.3	Constructive heuristic	48
4.3.1	First Step: generation of a sequence of containers	48
4.3.2	Second Step: dynamic I/O assignment and timing	50
4.3.3	Local search method	51
4.4	Computational experiments	54
4.4.1	Computational environment	54
4.4.2	Benchmark instances	54
4.4.3	Computational results of the heuristic methods	57
4.5	Conclusions	66
5	Solving the YCSP with Greedy Randomized Adaptive Search Procedures (GRASP)	67
5.1	GRASP	67
5.2	GRASP for the YCSP	69
5.2.1	GRASP constructive method 1	69
5.2.2	GRASP constructive method 2	71
5.3	Computational experiments	72
5.3.1	New calibration instances	72
5.3.2	Calibration of the proposed GRASP	73
5.3.3	Computational results	75

5.3.4	Sensitivity analysis	80
5.4	Conclusions	83
6	Solving the YCSP with Iterated Greedy methods	85
6.1	Iterated Greedy (IG)	85
6.2	Operators of the proposed IG	87
6.2.1	Destruction procedure	88
6.2.2	Reconstruction procedure	89
6.2.3	Local search	90
6.2.4	Acceptance criterion	93
6.3	Proposed IG methods	94
6.3.1	The proposed vanilla IG: IG0	94
6.3.2	The first proposed IG method: IG1	95
6.3.3	The second proposed IG method: IG2	96
6.3.4	The third proposed IG method: IG3	97
6.4	Computational and statistical experimentation	98
6.4.1	Experimental instances and settings	98
6.4.2	Statistical calibration	99
6.4.3	Comparison of methods	102
6.5	Conclusions	107
7	Conclusions and future work	109
7.1	Summary of the thesis	109
7.2	Academic activities and publications	110
7.3	Future lines of research	112
A	Instance example	115
B	ANOVA tables and calibration of methods	117
C	Design procedure and calibration of LS1	123
	Bibliography	131