

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>Part I Problem Description</b>		
<b>2</b>	<b>City Logistics</b>	<b>9</b>
2.1	Challenges	9
2.1.1	Evolution of Supply Chains	10
2.1.2	Increasing (Freight) Traffic	12
2.2	Solution Concepts	12
2.2.1	Perspective of Different Stakeholders	14
2.2.2	Urban Consolidation Centers	15
2.2.3	City Logistics Initiatives	16
2.3	Modeling	17
2.4	Planning Systems	19
2.4.1	Levels of Planning	19
2.4.2	Architecture of a Planning System	20
<b>3</b>	<b>Attended Home Delivery</b>	<b>23</b>
3.1	Online Retail	23
3.2	Types of Last-Mile Delivery	26
3.3	Customer Time Windows	29
3.3.1	Tactical Planning	29
3.3.2	Operational Planning	30
3.4	Implications	31
<b>Part II Information Models</b>		
<b>4</b>	<b>Knowledge Discovery and Data Mining</b>	<b>37</b>
4.1	Knowledge Discovery Process	37
4.1.1	Preprocessing	39

4.1.2	Data Mining . . . . .	41
4.1.3	Verification . . . . .	43
4.2	Cluster Analysis . . . . .	44
4.2.1	Clustering Approaches . . . . .	46
4.2.2	Clustering Algorithms . . . . .	48
4.2.3	Validation of Clusterings . . . . .	52
4.3	Exploratory Data Analysis . . . . .	55
<b>5</b>	<b>Analysis of Floating Car Data . . . . .</b>	<b>59</b>
5.1	Data Collection . . . . .	61
5.1.1	Traditional Approach . . . . .	61
5.1.2	Telematics-Based Approach . . . . .	62
5.2	Preprocessing . . . . .	66
5.2.1	Attribute “Time” . . . . .	66
5.2.2	Attribute “Link” . . . . .	66
5.2.3	Attribute “Speed” . . . . .	67
5.2.4	Temporal Distribution of Measurements . . . . .	68
5.2.5	Spatial Distribution of Measurements . . . . .	68
5.3	First Level Aggregation . . . . .	69
5.4	Second Level Aggregation . . . . .	72
5.4.1	Preprocessing . . . . .	72
5.4.2	Clustering Tendency . . . . .	72
5.4.3	Clustering Approach . . . . .	73
5.4.4	Number of Clusters . . . . .	74
5.5	Exploratory Data Analysis . . . . .	75
5.5.1	First Level Aggregation . . . . .	76
5.5.2	Second Level Aggregation . . . . .	78

### **Part III Integration of Information Models**

<b>6</b>	<b>Provision of Distance Matrices . . . . .</b>	<b>83</b>
6.1	Static Information Models . . . . .	86
6.1.1	Digital Roadmap . . . . .	86
6.1.2	Implementation . . . . .	89
6.2	Time-Dependent Information Models . . . . .	90
6.2.1	Modeling of Time Dependence . . . . .	91
6.2.2	Implementation . . . . .	97
6.3	Computation of Shortest Paths . . . . .	100
6.3.1	Shortest Path Problem . . . . .	100
6.3.2	Time-Dependent Shortest Path Problem . . . . .	102

<b>7</b>	<b>Evaluation of Information Models . . . . .</b>	<b>105</b>
7.1	Experimental Setup . . . . .	105
7.1.1	Traveler Scenarios . . . . .	106
7.1.2	Traffic Scenarios . . . . .	106
7.1.3	Information Models . . . . .	107
7.2	Simulation and Evaluation of Shortest Paths . . . . .	107
7.3	Computational Results . . . . .	109
7.3.1	Evaluation of Example Itineraries . . . . .	109
7.3.2	Overall Evaluation . . . . .	112

## Part IV Optimization Models

<b>8</b>	<b>Routing in City Logistics . . . . .</b>	<b>119</b>
8.1	Routing of a Single Vehicle . . . . .	120
8.1.1	Traveling Salesman Problem . . . . .	120
8.1.2	Time-Dependent Traveling Salesman Problem . . . . .	127
8.2	Routing of a Fleet of Vehicles . . . . .	134
8.2.1	Vehicle Routing Problem . . . . .	134
8.2.2	Time-Dependent Vehicle Routing Problem . . . . .	137
8.3	Customer Time Windows . . . . .	140
8.3.1	Vehicle Routing Problem with Time Windows . . . . .	141
8.3.2	Time-Dependent Vehicle Routing Problem with Time Windows . . . . .	145
<b>9</b>	<b>Evaluation of Optimization Models . . . . .</b>	<b>157</b>
9.1	Experimental Setup . . . . .	157
9.1.1	Customer Scenarios . . . . .	158
9.1.2	Information Models . . . . .	158
9.1.3	Evaluation of Heuristics . . . . .	159
9.2	Routing of a Single Vehicle . . . . .	161
9.2.1	Customer Scenario 1 . . . . .	162
9.2.2	Customer Scenario 2 . . . . .	164
9.2.3	Customer Scenario 3 . . . . .	165
9.3	Routing of a Fleet of Vehicles . . . . .	168
9.3.1	Performance of Neighborhood Operators . . . . .	168
9.3.2	Computational Results . . . . .	170
9.4	Customer Time Windows . . . . .	172
9.4.1	Role of Customer Time Windows . . . . .	173
9.4.2	Simulation of Customer Time Windows . . . . .	173
9.4.3	Computational Results . . . . .	174

<b>10 Conclusions and Outlook</b> . . . . .	179
<b>References</b> . . . . .	183
<b>Index</b> . . . . .	195



<http://www.springer.com/978-1-4614-3627-0>

Integration of Information and Optimization Models for  
Routing in City Logistics

Ehmke, J.

2012, XIV, 198 p., Hardcover

ISBN: 978-1-4614-3627-0