

Urban Freight Analytics

Big Data, Models, and Artificial Intelligence

Eiichi Taniguchi
Russell G. Thompson
Ali G. Qureshi



CRC Press

Taylor & Francis Group

Boca Raton · London · New York

CRC Press is an imprint of the
Taylor & Francis Group, an informa business

Contents

<i>Preface</i>	xi
<i>About the Authors</i>	xv

PART I
Methods **I**

1 Introduction **3**

1.1	<i>Concepts of city logistics</i>	3
1.2	<i>Use of emerging technologies</i>	4
1.2.1	<i>Overview</i>	4
1.2.2	<i>ICT, ITS, IoT, big data, and AI</i>	5
1.2.3	<i>Autonomous vehicles and robots for last-mile delivery</i>	6
1.3	<i>Collaboration and coordination among stakeholders</i>	7
1.4	<i>Integrated platform for city logistics</i>	8
1.5	<i>Modelling city logistics</i>	10
1.6	<i>Conclusions</i>	12
	<i>References</i>	12

2 Data collection and analyses **17**

2.1	<i>Data collection using IoT, ICT, and ITS</i>	17
2.1.1	<i>VICS data</i>	18
2.1.2	<i>Probe data</i>	19
2.2	<i>Big data analyses in urban freight</i>	21
2.3	<i>Data sharing among stakeholders</i>	21
2.3.1	<i>Overview</i>	21
2.3.2	<i>Examples of data sharing</i>	22

2.3.3	<i>Discussion</i>	23
2.3.4	<i>Blockchain</i>	24
2.4	<i>Conclusions</i>	25
	<i>References</i>	25
3	Geographic information systems and spatial analysis	27
3.1	<i>Introduction</i>	27
3.2	<i>Global position systems</i>	27
3.2.1	<i>Introduction</i>	27
3.2.2	<i>Vehicle routes</i>	27
3.2.3	<i>Road network performance</i>	29
3.2.4	<i>Freight vehicle demand</i>	30
3.3	<i>Geographic information systems (GIS)</i>	30
3.3.1	<i>Introduction</i>	30
3.3.2	<i>Overlaying</i>	30
3.3.3	<i>HazMat vehicle route planning</i>	33
3.4	<i>Data and software</i>	34
3.5	<i>Conclusions</i>	35
	<i>References</i>	35
4	Optimisation	39
4.1	<i>Introduction</i>	39
4.2	<i>Vehicle routing problem</i>	39
4.2.1	<i>The vehicle routing problem with time windows</i>	40
4.2.2	<i>Dynamic VRPs</i>	42
4.2.3	<i>Stochastic VRPs</i>	43
4.2.4	<i>Green VRPs</i>	44
4.2.5	<i>Heterogeneous vehicle routing problem</i>	45
4.3	<i>Location-routing problem</i>	46
4.4	<i>Multi-echelon routing and location-routing models</i>	47
4.5	<i>Hub location-routing problem</i>	49
4.6	<i>Solution techniques for VRPTW</i>	49
4.6.1	<i>Heuristics solution approaches</i>	50
4.6.2	<i>Exact solution approaches</i>	51
4.7	<i>Conclusions</i>	53
	<i>References</i>	53
5	Multi-agent simulation with machine learning	61
5.1	<i>Introduction</i>	61
5.2	<i>Multi-agent modelling</i>	61

5.3	<i>Decision support systems</i>	63
5.4	<i>Conclusions</i>	64
	<i>References</i>	64
6	Reliability and resilience	67
6.1	<i>Introduction</i>	67
6.2	<i>Travel time reliability in city logistics</i>	69
6.3	<i>Risks in hazardous materials transport</i>	70
6.4	<i>Resilience in disasters</i>	72
6.5	<i>Conclusions</i>	72
	<i>References</i>	73
7	Evaluation	75
7.1	<i>Introduction</i>	75
7.2	<i>Networks</i>	76
	7.2.1 <i>Retail swap networks</i>	77
	7.2.2 <i>Collaborative urban freight networks</i>	78
	7.2.3 <i>Urban shuttle</i>	79
	7.2.4 <i>Parcel lockers for transferring goods</i>	80
7.3	<i>Financial analysis</i>	80
	7.3.1 <i>Electric freight vehicles</i>	80
	7.3.2 <i>Software</i>	84
	7.3.3 <i>Urban consolidation centres</i>	84
7.4	<i>Multi-criteria analysis (MCA)</i>	85
	7.4.1 <i>Radar plot</i>	85
	7.4.2 <i>Priority weightings</i>	85
	7.4.3 <i>Promethee</i>	86
	7.4.4 <i>Combined methods</i>	87
	7.4.5 <i>Knowledge management</i>	88
7.5	<i>Multi-actor multi-criteria analysis</i>	88
7.6	<i>Multi-objective optimisation</i>	89
7.7	<i>Conclusions</i>	90
	<i>References</i>	91
PART 2		
Applications		93
8	Autonomous vehicles and robots	95
8.1	<i>Introduction</i>	95

- 8.2 *Types of un-manned vehicles in freight* 95
 - 8.2.1 *Autonomous delivery robots* 95
 - 8.2.2 *Un-manned aerial vehicles* 97
- 8.3 *Issues related with ADVs* 98
 - 8.3.1 *Capacity and range* 98
 - 8.3.2 *Regulations* 98
 - 8.3.3 *Acceptability* 99
- 8.4 *Integration of robots and drones in urban freight delivery systems* 101
- 8.5 *Indoor logistics* 103
- 8.6 *Conclusions* 103
- References* 104

9 Access management and pricing

109

- 9.1 *Introduction* 109
- 9.2 *Unloading bays* 109
 - 9.2.1 *Monitoring usage* 109
 - 9.2.2 *Models* 111
- 9.3 *Loading docks* 113
 - 9.3.1 *Surveys* 113
 - 9.3.2 *Capacity modelling* 114
 - 9.3.3 *Loading dock booking systems* 115
- 9.4 *Access control schemes* 119
 - 9.4.1 *Time access restrictions* 121
 - 9.4.2 *Vehicle restrictions* 121
 - 9.4.3 *Low-emission zones/environmental zones (engine restrictions)* 122
 - 9.4.4 *Vehicle load factor controls* 123
- 9.5 *Tolls* 123
- 9.6 *Road pricing* 124
- 9.7 *Conclusions* 125
- References* 125

10 Environmental sustainability

129

- 10.1 *Introduction* 129
- 10.2 *Joint delivery systems with urban consolidation centres (UCC)* 130
- 10.3 *Cargo bikes* 133
- 10.4 *Conclusions* 134
- References* 134

11	Disruption of networks	137
11.1	<i>Introduction</i>	137
11.2	<i>Humanitarian logistics in disasters</i>	138
11.2.1	<i>Routing problem</i>	138
11.2.2	<i>Location-routing problem</i>	139
11.3	<i>Recovery process</i>	143
11.3.1	<i>Debris removal</i>	143
11.3.2	<i>Network recovery</i>	145
11.4	<i>Logistics in pandemic times (COVID-19)</i>	146
11.5	<i>Conclusions</i>	147
	<i>References</i>	147
12	Future directions	151
12.1	<i>Introduction</i>	151
12.2	<i>Hyperconnected City Logistics</i>	152
12.3	<i>Emerging technologies</i>	154
12.3.1	<i>Connected and autonomous vehicles</i>	154
12.3.2	<i>Electric vehicles</i>	155
12.3.3	<i>Digital twin (DT)</i>	155
12.3.4	<i>Data</i>	156
12.4	<i>Integrated platform</i>	156
12.4.1	<i>Platform characteristics</i>	156
12.4.2	<i>Agent-based simulation models (ABSM)</i>	159
12.4.3	<i>Gamification</i>	160
12.4.4	<i>Optimisation</i>	161
12.4.5	<i>Machine learning (ML)</i>	163
12.5	<i>Conclusions</i>	163
	<i>References</i>	164
	<i>Index</i>	165