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The impact of flexible warehouse lease contracts on the configuration of a two-echelon distribution network

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SUPPLEMENTARY MATERIAL

This document contains the supplementary material to the following book chapter:

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The summary and keywords of the chapter are included next.

Abstract

Facility location decisions play a critical role in the design of supply chain networks. This chapter outlines key features of facility location problems and their integration with various logistic operations in the context of network (re)design. Modeling approaches and solution methods are also discussed for these challenging combinatorial optimization problems. In addition, we examine five emerging trends that will continue to drive research in this area, namely, sustainable development, the transition to a circular economy, data source-related issues, disruptive events and resilience, and omnichannel distribution in the retail sector. We review and classify recent contributions, identify research gaps, and provide directions for future research.

Keywords

Facility location, Sustainable network design, Circular economy, Data scarcity, Resilience, Omnichannel.

Tables with all numbered references

Table 1 Comprehensive classification of FLPs

Key feature	Aspect	Recent study
Number of objectives	☒single objective (total cost/profit)	[49]
	☒multi-objective (e.g., total cost + responsiveness)	[65]
Type of objective function	☒covering (set covering) ☒ median (p-median) ☒ center (p-center) ☒ hierarchical (successively inclusive) ☒ flow capturing ☒ hub location ☒ dispersion (p-dispersion) ☒ anti-median & anti-center	[37]
Number of facilities	☒single facility (no demand allocation)	[159]
	☒ multiple facilities	[136]
Decision space	☒ continuous (points of a continuous space)	[99]
	☒ discrete (finite list of potential sites)	[184]
	☒ graph (located on vertices/arcs)	[45]
Number of commodities	☒ single commodity	[178]
	☒ multi-commodity	[38]
Planning horizon	☒ single period	[44]
	☒ multi-period	[48]
Input parameters	☒ deterministic	[78]
	☒ probabilistic	[208]
	☒ possibilistic	[76]
Capacity configuration	☒ static (unlimited and limited capacity)	[127]
	☒ dynamic setting (expansion and contraction)	[47]
Supply chain structure	☒ single echelon	[46]
	☒ multi-echelon	[52]
Facility typology	☒ single type (e.g., warehouses)	[159]
	☒ multi-type (e.g., warehouses, stores)	[16]
Competition & cooperation	☒ with interaction (multiple players)	[54]
	☒ without interaction (single player)	[127]
Integration with other decisions	☒ location-routing models	[204]
	☒ location-inventory models	[155]
	☒ location-inventory-routing models	[189]

Table 2 Performance indicators of SCND models addressing all dimensions of sustainability

Performance indicator	Studied aspect	Reviewed article
Economic	cost	[6], [10], [11], [26], [33], [59], [72], [76], [77], [81], [90], [94], [95], [115], [136], [137], [164], [165], [166], [176], [181], [201], [210], [227], [229], [230], [232]
	profit	[73], [79], [145], [147], [148], [169], [183], [191], [192], [234]
Environmental	facility location	[6], [10], [11], [59], [76], [77], [81], [90], [94], [95], [147], [148], [165], [169], [181]
	procurement	[6], [11], [79], [94], [95], [183], [227], [229]
	production	[6], [11], [26], [59], [72]+, [76], [77], [79], [81], [90], [94], [95], [137], [145], [147], [148], [165], [166], [169], [176], [181], [183], [191]+, [201], [227], [229]
	material handling	[11], [59] [73]+, [81], [90], [94], [95], [145], [165], [166], [169], [181], [183], [201], [227], [229]
	transportation	[6], [10], [11], [26], [33], [59], [72]+, [76], [77], [79], [81], [90]+, [94], [95], [136], [137], [145], [147], [148], [165], [166], [169], [176], [181], [183], [191]+, [192]+, [201], [210], [227], [229], [230], [232]
	recycling/disposal	[11], [59], [79], [227], [229]
	energy consumption	[76], [77], [137]
	waste generation	[11], [76], [77], [95], [136], [164], [234]
	water consumption	[6], [76], [77], [137], [176], [191]+, [201]
	other indicators	[115], [164], [176]
Social	job creation	[6], [26], [59]++, [72], [79], [81], [95], [137]++, [145], [147], [148]++, [164], [165], [166]++, [169]++, [181]++, [183], [227]++, [229]++, [230], [232]
	accidents/damages	[59], [90], [95], [145], [164], [169], [181], [192]
	regional development	[10], [11], [33], [81], [165], [230]
	equity	[10], [90], [136]
	other indicators	[10], [11], [72], [73]+, [76], [77], [94], [95], [115], [176], [191], [201], [210], [234]

+indicator embedded in one or several constraints; ++consideration of fixed and variable number of job opportunities

Table 3 Classification of articles that use optimization methods to deal with supply chain disruptions

Article	Source of risk	Disruption	Application context
[74]	DD, SD, ED	DD1, SD1, ED1	glass sector
[174]	DD	DD4	automotive industry
[21]	SD	SD1, SD3	agri-business
[135]	DD, SD	DD2, SD1	
[60]	ED	ED1	humanitarian logistics
[122]	SD	SD1	HP case study
[86]	SD	SD1	filter manufacturer
[223]	ED	ED1	dairy industry
[83]	DD, SD	DD4, SD1	automotive industry
[186]	ED	ED3	COVID-19 vaccine supply
[161]	PD	PD1	pharmaceutical sector
[100]	ED	ED1	medical device manufacturer
[137]	DD	DD2, DD3	tire industry
[113]	ED	ED1	glass sector
[224]	ED	ED1	dairy industry
[195]	SD	SD1	printers-cartridge manufacturing
[97]	PD, ED	PD2, ED1	humanitarian logistics
[120]	ED	ED1	humanitarian logistics
[123]	ED	ED3	
[171]	SD	SD1	electronic manufacturing industry
[98]	ED	ED1	humanitarian logistics
[111]	SD	SD1	plastic sector
[179]	DR, SD, ED	DD2, SD1, ED1	pharmaceutical sector
[5]	ED	ED3	
[182]	DD, SD, ED	DD2, SD1, ED1	humanitarian logistics
[75]	ED	ED1	
[185]	ED	ED3	COVID-19 vaccine supply
[153]	SD	SD1	
[84]	ED	ED3	food sector
[207]	SD	SD1	pharmaceutical sector

PROCESS (PD): product quality problems (PD1), equipment failure (PD2), IT-driven problems (PD3), labor strike (PD4). **CONTROL** (CD): safety stock policy (CD1), ordering quantity policy (CD2), asset management policy (CD3), transportation management problems (CD4). **DEMAND** (DD): volatile demand (DD1), unanticipated demand (DD2), market changes (DD3), competition changes (DD4), forecasting errors (DD5), unusual customer payment delays (DD6). **SUPPLY** (SD): shortage in supply market (SD1), sudden supplier demise (SD2), variability of lead time (SD3), supplier quality problems (SD4). **ENVIRONMENTAL** (ED): natural disaster (ED1), terrorism and war (ED2), diseases and epidemics (ED3), political instability (ED4), technology changes (ED5)

Table 4 Selected features of articles addressing omnichannel network design

Studied component	Specific aspect	[14]	[39]	[92]	[104]	[126]	[130]	[132]	[142]	[143]	[219]	[220]	[221]
Main decision	Warehouse location		√	√			√		√	√			√
	Inventory in store	√		√	√		√	√	√	√		√	
	Demand allocation	√	√	√	√	√	√	√	√	√	√	√	√
	Customer behavior		√	√		√					√		
Objective function	Economic	√	√	√	√	√	√	√	√	√	√	√	√
	Environmental												√
	Social												
Modeling approach	MILP								√	√			√
	TS-MILP	√	√										
	LP			√								√	
	NLP				√	√	√	√			√		
Solution approach	Commercial software			√				√	√	√			√
	Exact method	√	√		√		√				√	√	
	Heuristic			√		√							
Flow type	Single product		√				√	√	√	√	√	√	√
	Multi-product	√		√	√	√							

- **Figures with all numbered references**

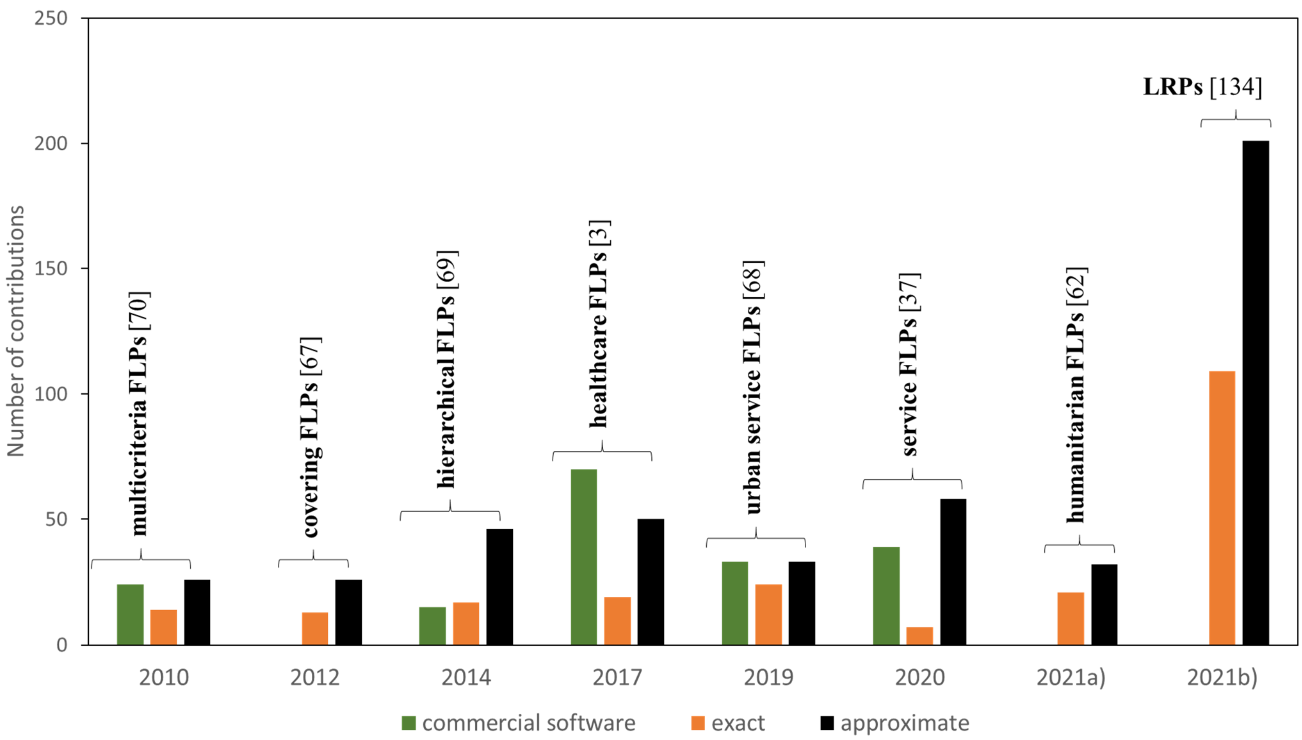


Fig. 2 Key review articles that provide comprehensive analyses of solution methods for FLPs

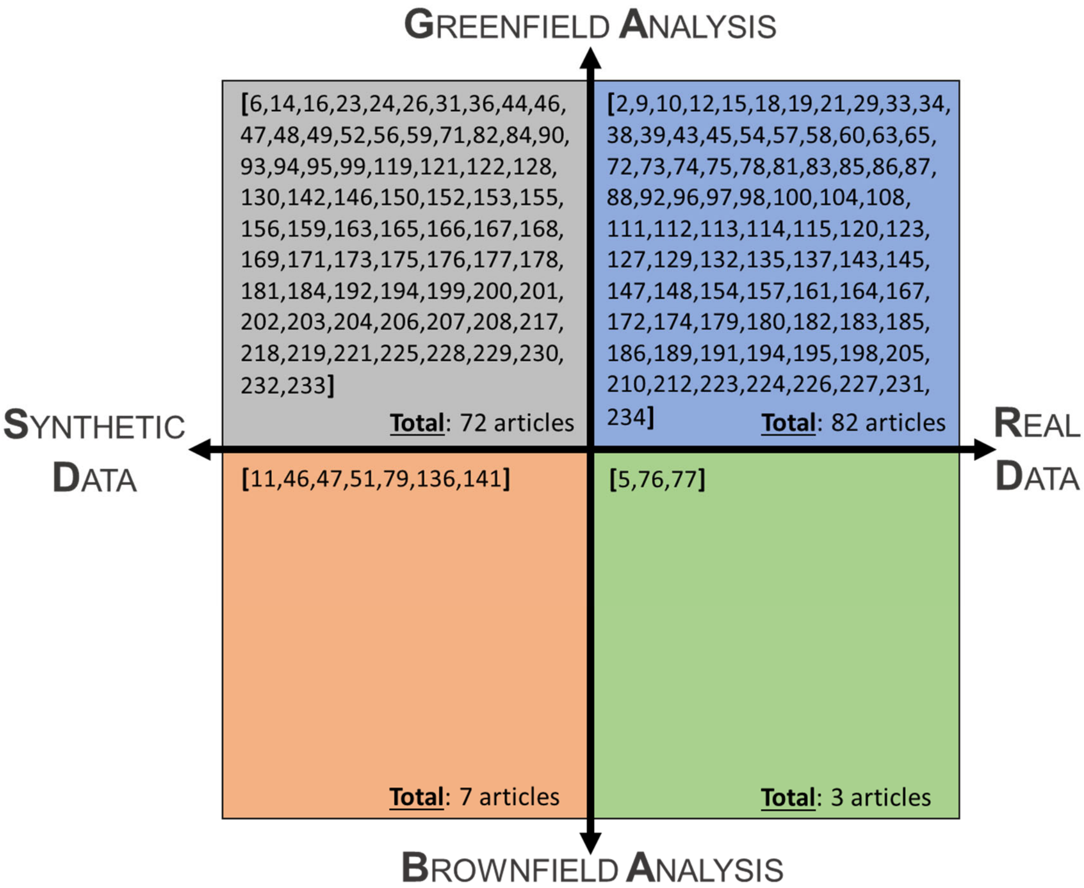


Fig. 3 General approaches and data sources used in the reviewed articles

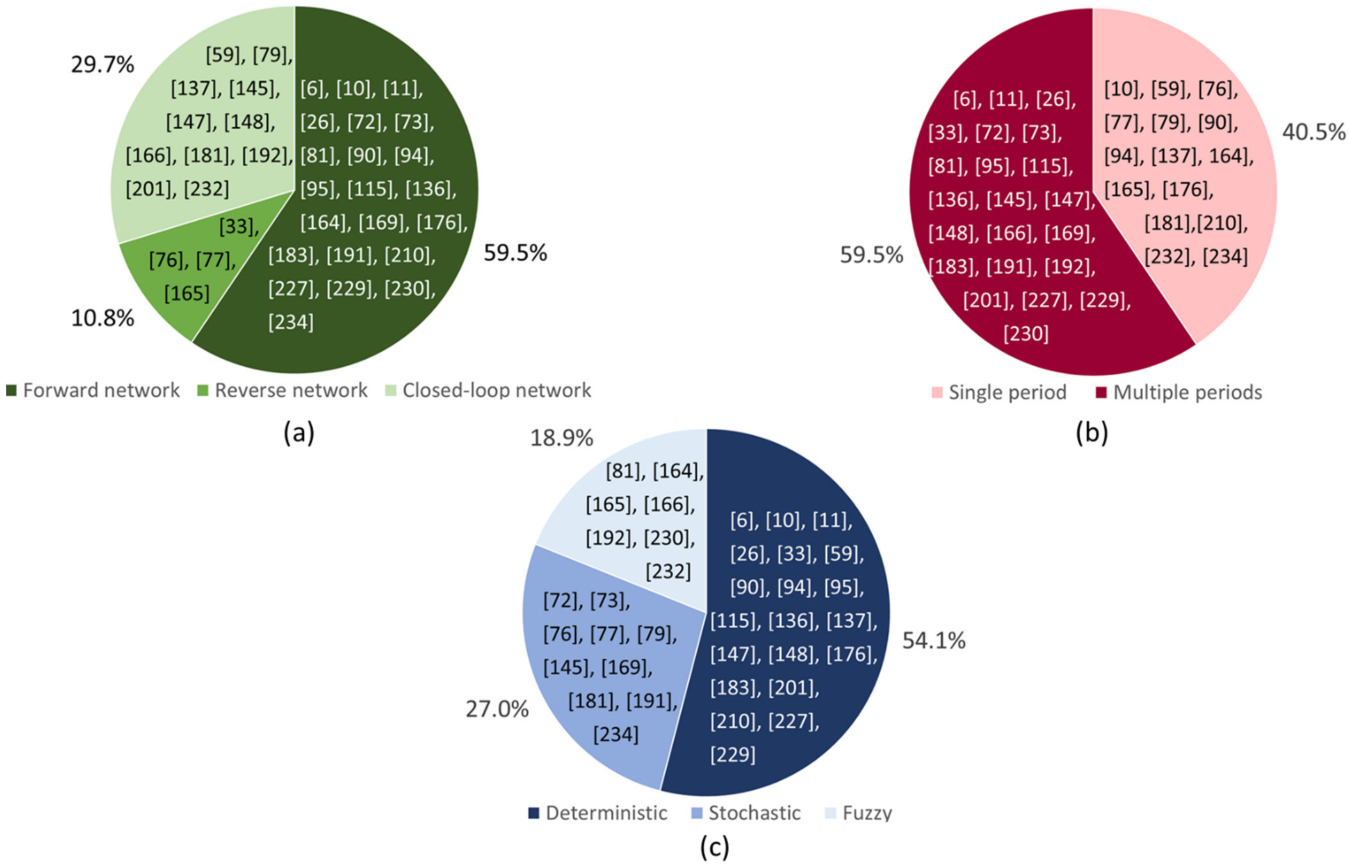


Fig. 4 Selected features of sustainable SCND models. (a) Type of supply chain network. (b) Planning horizon. (c) Type of modeling approach

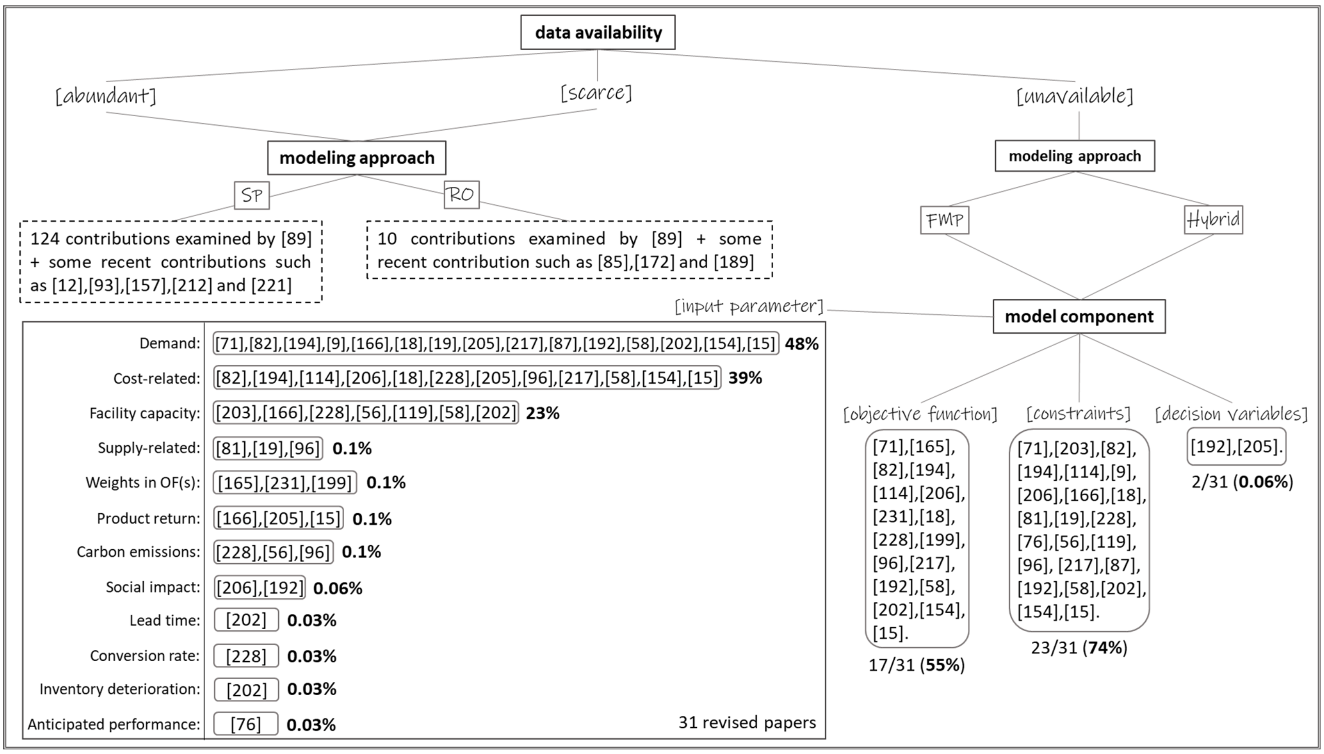
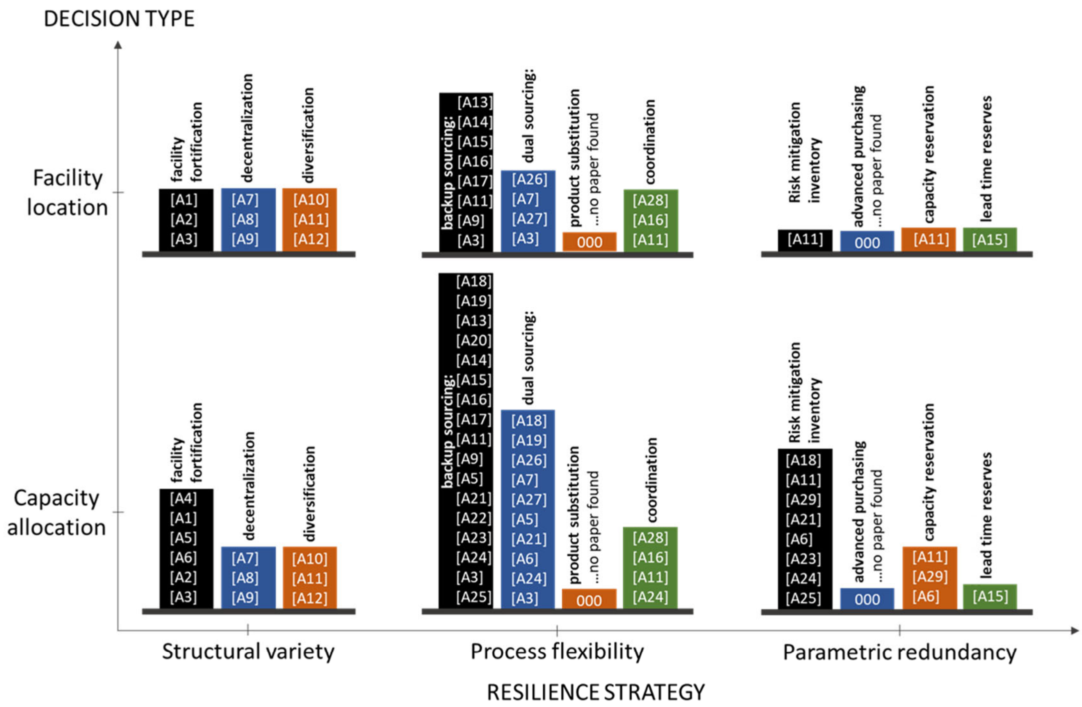


Fig. 5 Decision tree summarizing the DM environments and their respective modeling approaches



Revised articles:
Diabat et al. (2019) [A1]; Samani & Hosseini-Motlagh [A2]; Gholami-Zanjani et al. (2021) [A3]; Fattahi et al. (2017) [A4]; Jabbarzadeh et al. (2018a) [A5]; Alikhani et al. (2021) [A6]; Hasani et al. (2021) [A7]; Haeri et al. (2020) [A8]; Rajesh (2020) [A9]; Ghavamifar et al. (2018) [A10]; Yavari & Zaker (2020) [A11]; Kungwalsong et al. (2022) [A12]; Margolis et al. (2018) [A13]; Ghomi-Avili et al. (2018) [A14]; Sazvar et al. (2021) [A15]; Mehrjerdi & Shafiee (2021) [A16]; Jabbarzadeh et al. (2018b) [A17]; Rezapour et al. (2017) [A18]; Behzadi et al. (2017) [A19]; Kristianto et al. (2014) [A20]; Sabouhi et al. (2018) [A21]; Fattahi et al. (2020) [A22]; Sawik (2022) [A23]; Namdar et al. (2018) [A24]; Tucker et al. (2020) [A25]; Yavari & Zaker (2019) [A26]; Haghjoo et al. (2020) [A27]; Pariazar & Sir (2018) [A28]; Taleizadeh et al. (2022) [A29]

Fig. 6 Review of resilience strategies applied in disruptive supply chains

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Keywords: facility location, multi-period, capacity expansion and contraction, delivery lateness, mixed-integer linear models

(42 pages, 2016)

12 A. Bernhardt, T. Melo, T. Bousonville, H. Kopfer

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Keywords: road transportation, driver scheduling, rest periods, breaks, driving hours, Regulation (EC) No 561/2006, mixed integer linear programming models

(137 pages, 2016)

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Redesigning a food bank supply chain network, Part II: Computational study

Keywords: food rescue and delivery, sustainability, supply chain network design, tri-objective problem, social impact, economic and environmental performance

(57 pages, 2017)

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Keywords: road transportation, refueling, fuel cost, driver scheduling, rest periods, breaks, driving hours, Regulation (EC) No 561/2006, mixed integer linear programming

(90 pages, 2017)

15 M.J. Cortinhal, M.J. Lopes, M.T. Melo

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Keywords: supply chain network design, facility location, supplier selection, in-house production, product outsourcing, transportation mode selection, single-assignment, mixed-integer linear programming

(51 pages, 2018)

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(41 pages, 2019)

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18 A. Aliano Filho, T. Melo, M. Vaz Pato

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(49 pages, 2021)

20 Y. Costa, T. Melo

Supplementary material to the book chapter "*Facility Location Modeling in Supply Chain Network Design: Current State and Emerging Trends*"

Keywords: Facility location, Sustainable network design, Circular economy, Data scarcity, Resilience, Omnichanel

(23 pages, 2022)

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