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Naoum Tsolakis, Dimitris Zissis, Benny Tjahjono



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Scrutinising the Interplay between Governance and Resilience in Supply Chain

Management: A Systems Thinking Framework

Naoum Tsolakis, nt377@cam.ac.uk, +44(0) 1223 765599

Department of Engineering, University of Cambridge, Cambridge, UK, CB3 0FS

Dimitris Zisis, D.Zisis@uea.ac.uk, +44(0) 1603 592553

Norwich Business School, University of East Anglia, Norwich, UK, NR4 7TJ

Benny Tjahjono, benny.tjahjono@coventry.ac.uk, +44(0) 2477 654847

Centre for Business in Society, Coventry University, Coventry, UK, CV1 5FB

Corresponding author: Dimitris Zisis

1 **Scrutinising the Interplay between Governance and Resilience in Supply** 2 **Chain Management: A Systems Thinking Framework**

3 4 **Abstract**

5 Supply chain disruptions recurrently challenge end-to-end operations owing to the
6 ambiguous understanding of the role of governance in impacting supply network resilience.
7 This paper scrutinises the relevant literature to understand the plethora of interpretations in
8 the domain of supply chain governance and resilience while further provides a new
9 perspective on the representation of the interplay between governance and resilience in
10 supply chains. In this regard, the Systems Thinking lens is adopted to pull together the
11 typologies and constructs of supply chain governance and resilience from the literature.
12 Methodologically, System Dynamics modelling principles are leveraged to capture the
13 underpinning structural interdependencies in a causal loop diagram (CLD). The study reveals
14 that endogenous and exogenous supply chain governance processes and mechanisms
15 support the intrinsic and extrinsic resilience in networks. Overall, this research contributes to
16 the supply chain risk management domain by synthesising the interplay between governance
17 and resilience, identifying pertinent typologies and through articulating research propositions
18 that can inform decision-making at policy and managerial levels.

19
20 **Keywords:** supply chain risk management; governance; resilience; systems thinking; system
21 dynamics.

22 23 **1. Introduction**

24 Supply chain (SC) disruptions, rooted either in natural disasters or man-made upheavals,
25 often have a global impact that leads to high costs ranging from US\$150 billion in 2019 to
26 US\$350 billion in 2017 (Alicke and Strigel, 2020). Any kind of unanticipated SC disruptions will
27 inevitably affect global operations in terms, for example, delayed deliveries or cancelled
28 shipments due to closed ports, thus causing unmatched supply and demand. The risks may
29 increase due to modern practices in global sourcing involving multi-tier suppliers, and at the
30 same time, the related ramifications may exacerbate by the pressures to increase efficiency
31 and reduce inventory (Christopher and Peck, 2004).

32 There are many notable real-world cases reported in the literature about SC
33 disruptions triggered by unanticipated events. Indicatively, the workers' union strike on the
34 US West Coast in 2002 caused disruptions in containers' transshipment and deliveries to North
35 America and Europe, which affected operations for six months (Cavinato, 2004). In 2011,
36 Japan was struck by the Tohoku earthquake and the subsequent tsunami crippled global
37 manufacturing SCs (Son et al., 2021), including major automotive companies, such as Nissan,
38 Toyota, and General Motors, hence resulting in economic losses of about US\$235 billion
39 (Oskin, 2017). This catastrophic event also had implications beyond automotive, delaying,
40 among others, the delivery of Apple's iPad 2 tablet (Revilla and Sáenz, 2014) and disrupting
41 the retail SCs on a global scale (Todo et al., 2015; Torabi et al., 2015). In the same year,
42 Thailand experienced one of the worst floods that paralysed the country's transportation
43 facilities (Liu et al., 2016), forcing the computer hard disk drive manufacturer and data storage
44 company Western Digital to suspend manufacturing production (Fuller, 2011).

45 Although the effects of some disruptions may be relatively straightforward to manage,
46 others may have a much more significant impact on SCs' long-term performance and can be
47 detrimental to companies (Craighead et al., 2007; Schmidt and Raman, 2012). At a more
48 granular level, SC disruptions impact short- and medium-term financial performance due to
49 the ripple effect on the SC and corporate viability, regardless of firm size and/or
50 business/industrial sector. These impacts denote SC resilience as a leading theme in the
51 strategic corporate agendas (Baghersad and Zobel, 2021).

52 The COVID-19 pandemic reinvigorated the Operations Management community's
53 focus on resilience and highlighted the need to '*relearn lessons already learned in research*
54 *when the next crisis comes around*' (van Hoek, 2020). Notwithstanding the plethora of risk
55 management studies motivated by natural and man-made disasters, the pandemic further
56 highlighted the need to consider resilience from an intertwined supply network vantage point
57 (Ivanov and Dolgui, 2020). Such a systems perspective of supply networks is useful in guiding
58 the design of inclusive governance processes and mechanisms, which are paramount for
59 instituting resilient operations in post-crisis periods (Khurana et al., 2021). Governance of
60 people, processes, and technologies is a fundamental overarching element in Deloitte's Risk
61 Intelligent Enterprise Framework for SC resilience (Deloitte, 2012). The need for mitigating
62 the impacts of disruptions and planning in post-disaster eras highlights the requisite for
63 governance processes and mechanisms to ensure the resilience and rebound of SC operations

64 (Deloitte, 2020). The pandemic also clearly showed that organisational and institutional
65 governance structures are still incapable of understanding the vulnerabilities that lead to
66 disruptions in essential supplies, such as hand sanitizers, personal protective equipment (PPE)
67 and medical equipment (McKinsey and Company, 2020). Despite the magnitude of research
68 on the field of SC resilience, the COVID-19 pandemic does seem to teach us another important
69 lesson to comprehend the underpinning constructs/elements and structural
70 interdependence of SC governance and resilience. For example, the failure of global SCs for
71 medical supplies shows us that in the post-COVID-19 era, there is a pressing need to revisit
72 SC governance and resilience, and introduce dynamic and adaptable frameworks that can
73 support timely and sustainable interventions for properly addressing future pandemics
74 (Bhaskar et al., 2020). This need has instigated our first research question:

75 ***RQ1 – How can SC governance and resilience be understood from a supply network***
76 ***standpoint?***

77 The answer to RQ1 should identify key themes and structural elements of governance
78 and resilience in manufacturing networks. However, in the context of unprecedented
79 disruptions compounded by its uncertainties, there is a greater need to understand
80 underlying linkages between the elements of governance and resilience (Scheibe and
81 Blackhurst, 2017). Albeit the SC management imperative to understand the interplay
82 between governance and resilience to respond to internal and/or external shocks, this
83 remains a nascent research domain (Bakshi and Kleindorfer, 2009). Owing to the fact that the
84 structured analysis of the interplay between SC governance and resilience can be considered
85 as a complex dynamic system, we, therefore, propose our second research question:

86 ***RQ2 – What is the interplay between governance and resilience in a supply network***
87 ***system that can inform management directions?***

88 Thereafter, to respond to RQ2, we employ a logic of enquiry owing to the dynamic
89 nature of global disruptions and the associated impacts on SC operations (Forrester, 1961).
90 This dynamic interrelation implies that governance, and subsequently resilience, need to be
91 understood from an inter-organisational and supply network systems' viewpoint (Ahlqvist et
92 al., 2020). As the notion of SC resilience has to be theorised within a structural and operational
93 dynamics frame (Ivanov and Sokolov, 2019) and considering the role of Systems Thinking as
94 an explanatory process in networked and collaborative governance (Forliano et al., 2020), we

95 argue that the systems analysis approach allows: (i) the investigation of the underpinning
96 mutual influences on the one end and (ii) the dynamic interrelations and feedback loops
97 pertaining governance and resilience (Stewart and Ivanov, 2019) on the other end.

98 Inspired by Ferreira de Araújo Lima et al. (2020), we perform an extensive literature
99 review, followed by a critical taxonomy of the outcomes. Using the findings from the
100 literature review and the critical taxonomy, we articulate research propositions pertaining to
101 SC governance and resilience. We take this analysis further by integrating the articulated
102 research propositions in a conceptual framework of a complex system linking SC governance
103 and resilience. In particular, the proposed systems thinking framework captures the interplay
104 among the corresponding structural elements to explore the underpinning dynamics.

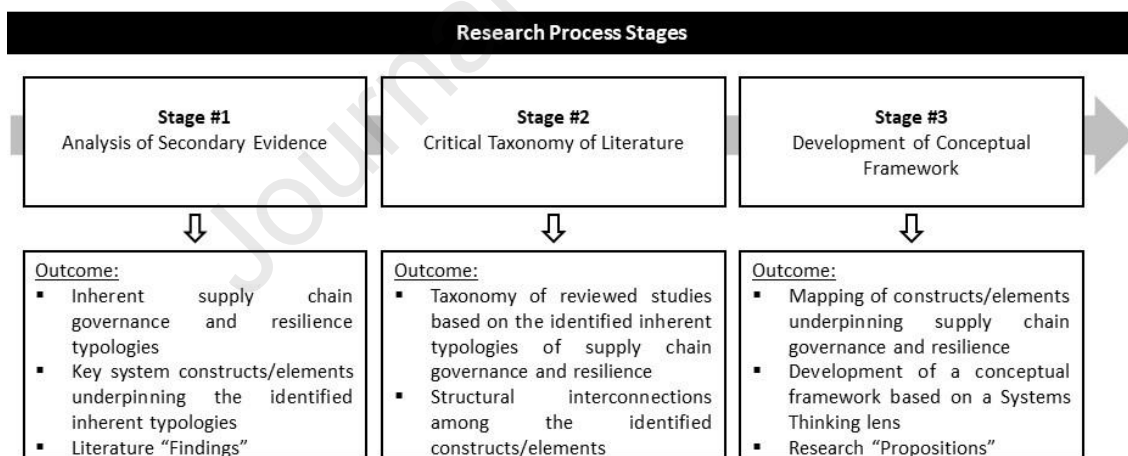
105 Our research contributes to the intersection of Operations Management and
106 governance fields by applying a systems perspective on the resilience of SC operations; thus,
107 developing a profound understanding regarding the pertinent role of managerial governance,
108 which posits an open issue for policy-making silos and corporate management alike. In this
109 way, this research clarifies the dynamic interlinkages between SC governance and resilience,
110 and informs public and private organisations concerning the impact of governance-centric
111 interventions on SC resilience. From a pragmatic standpoint, the first COVID-19 lockdown
112 across the retail sectors in several countries, occurred during March and April 2020,
113 highlighted a pertinent need on how such interventions can be facilitated in the future and
114 emphasised the lessons learned in that direction.

115 Considering the above, we organise the remainder of this paper as follows. Section 2
116 discusses the materials and methods related to this study. Section 3 outlines the concepts of
117 SC governance and resilience relying on existing qualitative evidence. We identify that SC
118 governance processes, mechanisms, and tools, which impact resilience, need to be
119 understood from both endogenous and exogenous perspectives. Additionally, we explore the
120 concept of SC resilience and we propose that it posits an intrinsic and extrinsic SC attribute.
121 The critical taxonomy of the reviewed literature is also provided. In Section 4, we present and
122 discuss the interplay between SC governance and resilience, in the form of a conceptual
123 framework based on Systems Thinking, and we articulate pertinent research propositions to
124 encourage potential research streams. Finally, in Section 5, the study concludes with a
125 discussion of the implications to theory and managerial practice. Limitations and
126 recommendations for future research are also provided.

127

128 **2. Materials and Methods**

129 Considering that this research focusses on developing a coherent conceptual structure about
 130 the interplay between SC governance and resilience, the object of scrutiny is the extant
 131 literature (Webster and Watson, 2002). In this regard, the overall research process includes
 132 three stages (Figure 1). In Stage #1, we analyse qualitative secondary evidence following a
 133 narrative review of the extant literature to identify underpinning SC governance and
 134 resilience inherent typologies, major system constructs (or elements) and their structural
 135 interconnections. To this effect, we express several key findings stemming from the reviewed
 136 literature. Following that, in Stage #2, we systematically retrieve pertinent studies on SC
 137 governance and resilience, and then, we critically taxonomise these based on identified
 138 inherent typologies. The taxonomy also informs any dominant interconnections between the
 139 system's constructs. In Stage #3, based on Systems Thinking, we map these constructs and
 140 their structural interrelations, and develop our conceptual framework. We also articulate
 141 future research propositions. The literature review protocol and the theoretical lens relevant
 142 to this study are exemplified in the following subsections.



143

144

Figure 1. Research methodology flowchart.

145 **2.1. Literature Analysis**

146 This research applies the traditional 'narrative review' approach involving informal
 147 approaches to organise and analyse the extant literature (Hammersley, 2001) seeking to
 148 identify relevant studies in the field of SC governance and resilience. To this end, we review a
 149 considerable number of articles published in peer-reviewed journals to identify inherent
 150 typologies in SC governance and resilience. At this initial stage, we select this approach, as
 151 opposed to a systematic review, owing to the intention to specify inherent typologies in SC

152 governance and resilience that is an evident knowledge gap in the field of SC management,
153 except for the extant dispersed and random empirical knowledge (Jones and Gatrell, 2014).

154 Thereafter, we carefully read the papers to familiarise ourselves with the topics and to
155 make sense of the used/provided data (Conz and Magnani, 2020). The main reason for this
156 content analysis is to coherently triangulate the evidence and understand the relevance of
157 the terms '*governance*' and '*resilience*' to other concepts in the SC literature. As a result, we
158 identify key inherent typologies and system constructs/elements thereof, transcending SC
159 governance and resilience. Furthermore, the synthesis of the literature review observations
160 leads us to collate and clearly articulate literature findings. The use of 'findings' is helpful as
161 a means of summarising thematically, important discoveries and breakthroughs from our
162 review hence limiting biases.

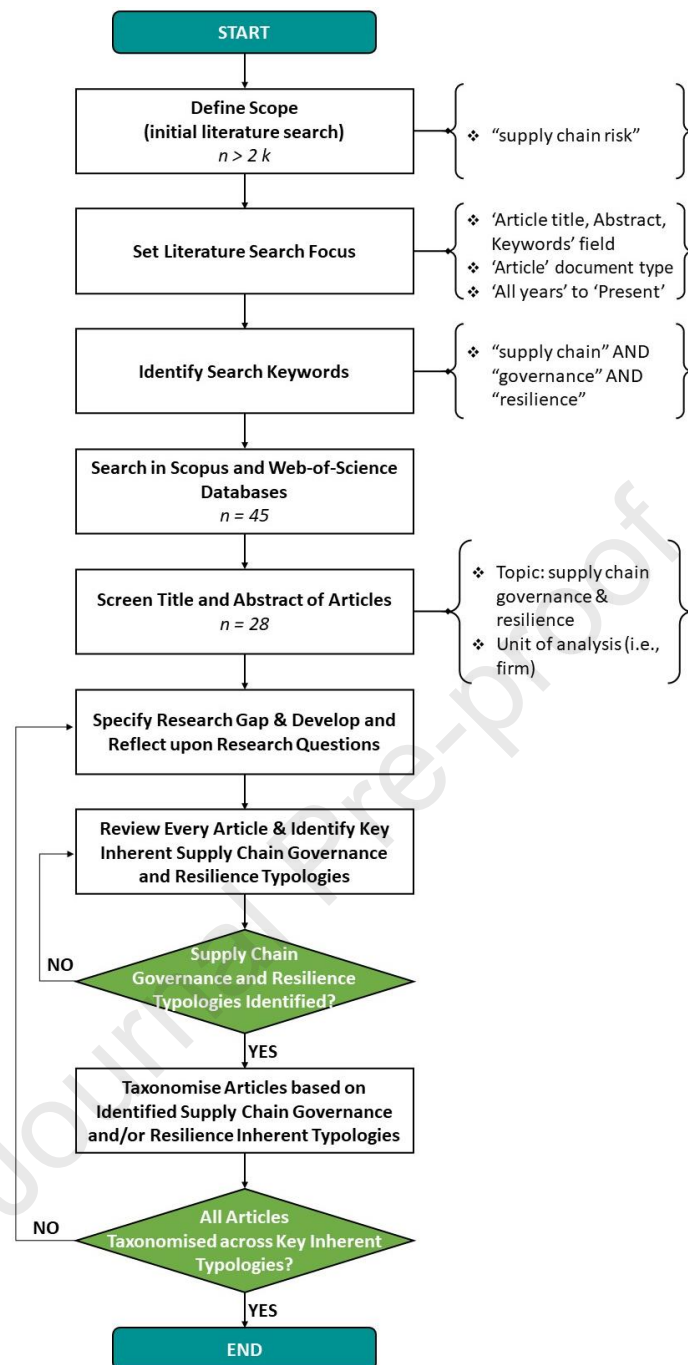
163 **2.2. Critical Taxonomy**

164 Following an established literature analysis norm (Åberg et al., 2019; Conz and Magnani,
165 2020; Ferreira de Araújo Lima et al., 2020) and considering the systems view of this research,
166 we proceed to a critical taxonomy of pertinent studies in the field. In this regard, we perform
167 an extensive literature review on the investigated topic by conducting structured Boolean-
168 type searches using appropriate keywords in the Scopus and Web of Science databases
169 (Aivazidou et al., 2016). These two databases are selected as they capture a wide range of
170 scientific journals in the fields of business and management, natural sciences and engineering
171 (Mongeon and Paul-Hus, 2016) where the research areas of governance and resilience are
172 usually represented in. The search strings that have been used are broad and comprise of the
173 following Boolean set: {"supply chain" AND "governance" AND "resilience"}. The search is
174 specified against the 'Article title, Abstract, Keywords' field. The time horizon of the
175 publications is left unrestricted.

176 Focussing on accessing '*best-quality evidence*' (Tranfield et al., 2003), the literature
177 search is limited to peer-reviewed journal articles written in English. We carefully examine
178 the content of every identified publication to validate its eligibility (e.g., purpose, findings,
179 and/or implications), along with their relevance to the research questions, while bearing in
180 mind the purpose of this research. By applying the above inclusion and quality assessment
181 criteria, we initially retrieve 45 articles. Title and abstract screenings are then performed using

182 criteria, including focus of the topic, the right level of analysis, the right context of application,
183 area of interest as well as unit of analysis (i.e., firms and not consumers).

184 By 31 January 2021, a total of 28 articles published in an equivalent number of
185 academic journals passed the quality assessment and are included for our critical taxonomy.
186 Table A1 (Appendix I) summarises the details of the articles that are included in the critical
187 taxonomy, as these are retrieved via the process flow depicted in Figure 2. The allocation of
188 the taxonomised scientific articles by year of publication is inserted in Figure A1 (Appendix I).
189 Notably, all the collected articles are published in different academic journals hence indicating
190 that the topic covers a wide variety of scientific areas, such as operations and SC
191 management, environmental sustainability, and public administration. A synopsis of the
192 reviewed articles is inserted in Appendix II.



193

194

Figure 2. Critical taxonomy process.

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197

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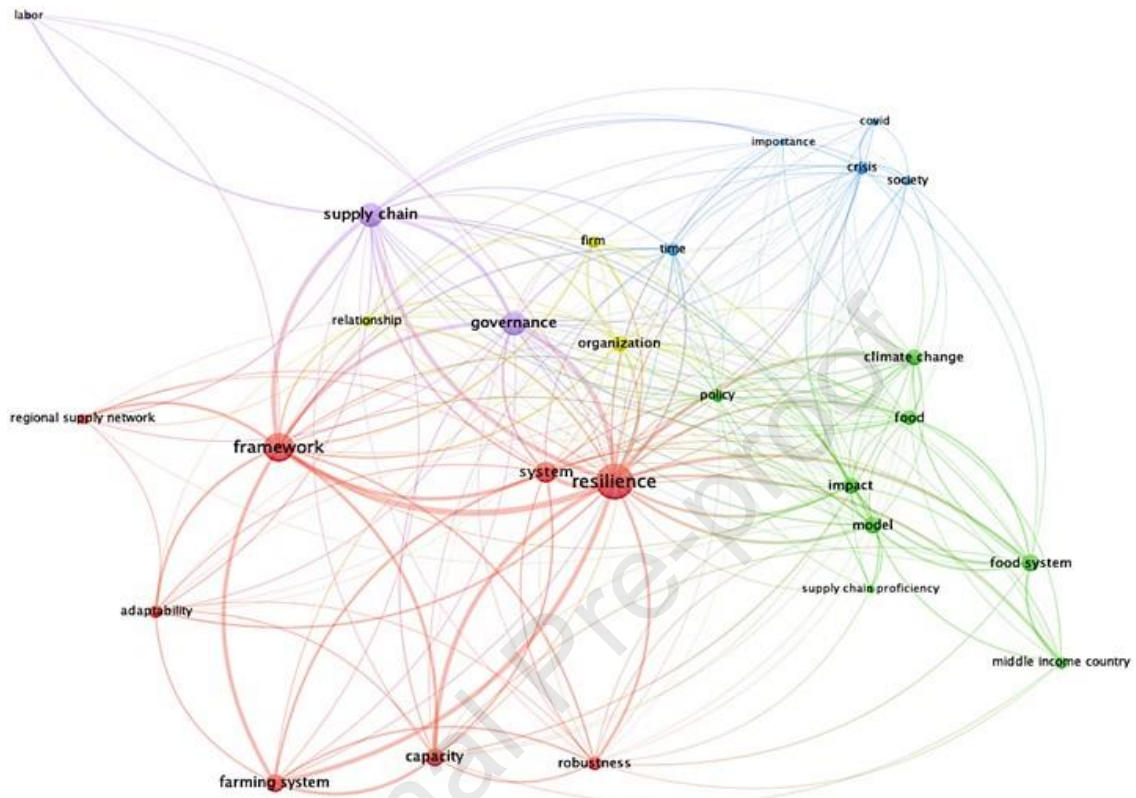
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201

The metadata of the identified articles are first used for a bibliometric analysis to unveil knowledge domains within the reviewed articles (Sodhi and Tang, 2017). The bibliometric analysis is based on the co-concurrence of keywords in the retrieved articles' titles and abstracts. The resulting network map is illustrated in Figure 3. The strength of the link between two terms (denoted by the thickness of every connection) indicates the number of publications in which these terms occur together, with the minimum number of co-occurrences set to five. The bibliometric map also indicates that five thematic categories,

202 visualised as clusters of terms (in different colour), are identified with 'supply chain' and
 203 'supply network' having a significant role and correlation with the terms 'governance' and
 204 'resilience' (indicated via the purple- and red-coloured connections, respectively).



205
 206 **Figure 3.** Keyword co-occurrence bibliometric map of the selected articles (generated by
 207 VOSviewer 1.6.16 software).

208 2.3. Theoretical Lens

209 Systems Thinking is selected as the theoretical lens under which the analysis of the literature
 210 is conducted. The reason for selecting this systems-level approach is that it provides an
 211 appropriate theoretical view for generating and guiding informative decision insights to SC
 212 actors for governance in risky environments, ultimately enhancing the overall network
 213 resilience (Govindan and Al-Ansari, 2019). In addition, the general models proposed by
 214 Charreaux (2008) and Wirtz (2011) consider corporate governance as a complex dynamic
 215 system of actors and mechanisms. To this end, a Systems Thinking approach could be valuable
 216 in understanding and mapping the fundamental cause and effect interrelations among
 217 governance and resilience across an SC system (Meadows, 1980).

218 Spiegel et al. (2012), among others, have studied the dynamics of SC systems and
 219 assessed alternative inventory and ordering control policies against resilience, having a view

220 on a specific process, thus providing a demonstration of the usefulness of Systems Thinking
221 as a way to link governance and SC operations. In a similar vein, extant studies have applied
222 systems-level analysis to investigate alternative SC management initiatives for sustainability
223 in multiple sectors, such as agrifood (Aivazidou and Tsolakis, 2021; Tsolakis et al., 2018).
224 Notwithstanding the fact that several similar studies in the literature have tried to approach
225 the topic of SC governance and resilience using other theoretical frameworks; to the best of
226 our knowledge, there is a lack of understanding over the system structure and the
227 underpinning interplay. Therefore, the dynamics view of systems provides an essential
228 actionable framework from a managerial perspective. In this context, this study aims to
229 provide a greater understanding of the dipole SC ‘governance–resilience’ with a Systems
230 Thinking outlook.

231 Based on the analysis of the literature and through the Systems Thinking lens, we create
232 a qualitative system map to support the visualisation of the system constructs’ structural
233 interrelations. Moreover, in a contemporary literature review, in order to demonstrate the
234 value and contributions from the review, researchers often take a step forward, that is, not
235 just collating extant evidence, but more importantly, trying to explain the connection
236 between existing concepts with a view to suggest or speculate future promising areas of
237 inquiry (Liliani et al., 2020). Therefore, we also articulate propositions for future research.

238

239 **3. Governance and Resilience in Supply Chain Management**

240 In this section, the structure of SC governance and resilience is being investigated to identify
241 key themes and structural elements to enhance a researcher’s understanding of the
242 underpinning interplay (Forrester, 1961). In the subsections that follow, evidence extracted
243 from the collected literature on SC governance and resilience is discussed and a series of
244 arguments over the research findings is formulated.

245 **3.1. Supply Chain Governance**

246 Governance is a term that is often used across many principles with the broad meaning of ‘*an*
247 *institutionalised decision-making process among many independent actors*’ (Ahlqvist et al.,
248 2020, p.383). Statsenko et al. (2018a) highlighted the role of formal (i.e., regulations,
249 incentives, programmes) and informal (i.e., social norms, trust, reputation) supply network
250 system governance to foster regional SC structure and connectivity for facilitating technology

251 and knowledge diffusion, thus promoting the resilience of regional economies. In the SC
252 management field, multi-echelon operations in global manufacturing networks imply the
253 need for the involved actors to comply with various national and international legislation and
254 certification standards to limit supply–demand uncertainty, ensure quality, and prevent
255 setbacks (Mazahir and Ardestani-Jaafari, 2020). At an inter-organisational level, contracts
256 detail the duties, rights, and contingencies of firms, and act as safeguards or coordination
257 means (Mesquita and Brush, 2008) to ensure the delivery of specific outputs and resolve any
258 conflicts (Ryall and Sampson, 2009).

259 In the same context, governance has been generally considered as a set of
260 mechanisms to support and manage the flow of products and services from suppliers to
261 customers and vice versa (Aitken and Harrison, 2013). For example, contracts and trust are
262 recognised as essential forms of contractual and relational governance mechanisms in SCs
263 that can improve performance and reduce opportunism; even in cases where international
264 network actors are located in countries with less effective legal systems (Cao and Lumineau,
265 2015).

266 In the SC management field, the concept of governance implies collaborations
267 between organisations participating in an SC, and among firms and governmental agencies,
268 with the ambition to fulfil the needs of diverse stakeholders. Therefore, in this study, we
269 argue that governance can be approached from different, yet complementary, viewpoints,
270 namely: (i) *endogenous governance*, that is, formal and informal processes, mechanisms, and
271 tools to manage the interrelations among network actors and (ii) *exogenous governance*, that
272 is, official regulations, rules, guidelines, and standards that have jurisdiction over extended
273 network operations. We outline these two viewpoints in the following subsections.

274 3.1.1. *Endogenous Governance*

275 Globalisation of manufacturing and business operations results in the formation of complex
276 multi-tier SCs with respective implications on: (i) performance (e.g., inventory and
277 transportation costs, responsiveness); (ii) power balance among SC actors; (iii) network
278 structure (i.e., open, closed); (iv) degree of interdependence among SC members; and (v)
279 stability of relationships among network actors (Mena et al., 2013). In addition, governance
280 structures are established to regulate transactions among actors in an SC and enable self-
281 enforcing agreements (Dyer and Singh, 1998). Gereffi et al. (2005) focussed on inter-firm

282 linkages and identified three essential factors in the governance of global value chains,
283 namely: (i) complexity of transactions; (ii) codifiability of information; and (iii) capabilities of
284 suppliers. The analysis reveals the pivotal role of tacit knowledge and interdependencies
285 among firms within a value chain in driving coordination and competence. Lumineau and
286 Henderson (2012) extended the aforementioned views by considering the influence of buyer–
287 supplier relationship experiences and specific contractual provisions to the design of SC
288 contractual and relational control mechanisms.

289 Interdependencies of stakeholders within supply networks include sharing resources
290 or trust to foster collaborations and integration for pursuing a common principal mission (Cao
291 et al., 2010) that can ultimately stimulate resilience. On a pragmatic view, natural disasters
292 and national security incidents indicate that collaboration, in this instance, between private
293 organisations and public institutions, can enable learning processes for developing a
294 responses' knowledge-base and guidelines for corrective actions thus enhancing resilience
295 (Committee on Homeland Security, 2008). From an environmental sustainability viewpoint,
296 SC governance implies the catalytic role of relations among network actors in achieving
297 certain performance objectives, typically focussing on lower tier suppliers (Walker and Jones,
298 2012). The diverse cultural background of SC partners has a detrimental role in the
299 development of informal endogenous governance mechanisms, further including trust,
300 communication style, and social bonding (Gupta and Gupta, 2019). Evidently, within an SC
301 system, interlinkages among actors are required for both forward and reverse flows (Aitken
302 and Harrison, 2013).

303 Therefore, we argue that endogenous SC governance can be regarded as the
304 combination of formal and informal arrangements that dictate both the transactional
305 commitments and the underpinning relational exchanges among the involved network
306 parties with regard to value chain flows (e.g., material, data and information, monetary).
307 Consequently, we have the following literature finding:

308 **Finding 1:** *Endogenous SC governance entails the portfolio of formal and informal*
309 *arrangements that regulate the business processes, the collaboration, and the*
310 *transactional relations among partners in end-to-end network echelons of*
311 *operations.*

312 **3.1.2. Exogenous Governance**

313 A plethora of exogenous developments exists regarding SC systems that impact network
314 operations and further entail the adoption of certain management interventions to propel
315 specific objectives, such as sustainable performance (Esfahbodi et al., 2017). In particular, it
316 is recognised that the ability of an SC to be resilient directly links to both the collaboration
317 degree among system stakeholders and the conformance to regulatory constraints imposed
318 by institutional bodies (Gabler et al., 2017). However, Meyer (2020) argued that a systems
319 perspective is required to consider the implications of global governance on the resilience at
320 regional settings.

321 Liability rules directly and indirectly shape food SCs by imposing the allocation of
322 obligations and responsibilities among network actors regarding quality and safety of the
323 traded commodities (Rouvière and Latouche, 2014). The notion of the enforcing role of laws,
324 regulations, jurisdictions and standards in end-to-end SC operations is also notable in the
325 mining and pharmaceuticals sectors with the purpose to ensure public health and safety,
326 avoid illegal practises, and prevent irresponsible material sourcing and counterfeits. To this
327 effect, nowadays, such requirements inform the design of traceability systems enabled by
328 digital technologies, such as blockchain (Hastig and Sodhi, 2020). Furthermore, to safeguard
329 SC resilience against supply disruptions, governmental regulations explore system-wide
330 adaptations in the pharmaceuticals landscape regarding, for example, the potential use of
331 renewable feedstocks as raw materials for the synthesis of active pharmaceutical ingredients
332 (Tsolakis and Srari, 2018). In the manufacturing sector, exogenous driving forces of governance
333 (i.e., institutional pressures) are also reported to act as a key impetus for firms to embrace
334 environmentally sustainable initiatives (Esfahbodi et al., 2017). In the food sector, Meuwissen
335 et al. (2019) recognised the need to ensure governance adaptability at policy-making levels
336 to foster resilience in the farming sector.

337 Consequently, this research recognises exogenous governance as the official
338 regulatory context and frameworks that legalise and safeguard SC operations; these
339 jurisdictions are external to the SC inter-organisational structure. This research considers only
340 the formal governance directives imposed by national and international regulatory bodies. As
341 a result, we have the following literature finding:

342 **Finding 2:** *Exogenous SC governance involves formal contexts entailing guidelines and*
343 *legislative norms that frame, regulate, and control end-to-end network operations*
344 *for delivering quality offerings to the market in sustainable manner.*

345 **3.2. Supply Chain Resilience**

346 Resilience in SC management is often defined as the *'ability to recover from disruptions and*
347 *return to the original state'* (Gligor et al., 2019, p.475). In this regard, resilience can be first
348 understood as a consequence of the internal structure of a firm or an SC that focusses on
349 nurturing capabilities, devising practices, and accessing resources to sufficiently manage
350 situations of internal instability (De Sanctis et al., 2018). For example, the adoption of Industry
351 4.0 constituent technologies, such as Big Data and Artificial Intelligence, is documented to
352 enhance multi-echelon SCs' resilience by allowing complete communication among the
353 dispersed and diverse actors (Ramirez-Peña et al., 2020). Digital-enabled real-time data
354 mining, transparency and visibility allow informed decision-making that leads to the efficient
355 design, planning, and management of operations, such as in the shipbuilding industry
356 (Ramirez-Peña et al., 2020).

357 However, as SC operations unfold in the global business and geographical landscapes,
358 the level of exposure to uncertainties, stresses, and shocks, such as extreme weather
359 conditions, is high thus challenging the overall networks' resilience (Govindan and Al-Ansari,
360 2019). Further external SC disruptions include the volatility of currency exchange rates,
361 customs delays at borders and cyber-attacks, which necessitate the synchronisation among
362 the decision-making processes of the involved network actors to enhance resilience
363 (Katsaliaki et al., 2021).

364 Noteworthy, despite the extended management literature with resilience-focussed
365 studies, the interchangeable use of the term with 'agility' is often contradictory and creates
366 confusion due to common schemes, such as operational flexibility. Indeed, SC agility refers to
367 the *'ability of the firm to adjust tactics and operations within its supply chain to respond to*
368 *environmental changes, opportunities, and threats'* (Dubey et al., 2018, p.131).

369 In SC management, the concept of resilience denotes the individual SC actors'
370 capabilities and the entire network to recover from disruptions and restore operations and
371 performance, to an even better state than the pre-crisis era. Consequently, we argue that
372 resilience needs to focus on different levels, namely: (a) *intrinsic resilience*, that is, set of
373 capabilities, processes, and tools to recover from internal disruptions that arise either at the
374 level of specific SC actors and/or across the end-to-end value network and (b) *extrinsic*
375 *resilience*, that is, standardised processes and mechanisms to respond and recover from
376 external to the SC of reference disruptions that can have a detrimental impact on the

377 operations across the entire network. We discuss these two viewpoints in the subsections
378 that follow.

379 3.2.1. *Intrinsic Resilience*

380 The availability of technical, organisational, and relational skills enables individual SC actors,
381 and the respective end-to-end networks, to accumulate knowledge and expertise to
382 effectively respond to internal shocks and recover promptly (Gilly et al., 2014). From an SC
383 perspective, rooted on the definition of resilience, the ability to manage uncertainties via
384 informed decision-making and recover SC operations requires end-to-end sharing of data,
385 information, and knowledge (Glickman and White, 2006), considering that '*information is the*
386 *substance from which the managerial decisions are made*' (Forrester, 1961, p.427). Therefore,
387 coordination and visibility among actors in an SC is crucial to orchestrate operations and
388 increase resilience (Christopher and Lee, 2004). In this regard, Emmanuel-Yusuf et al. (2017)
389 developed the Resilience and Livelihoods in Supply Chains (RELISC) framework to
390 comprehend supply systems' contextual factors to improve resilience, among others, and
391 revealed the catalytic role of visibility, adaptation, collaboration, and communication as
392 strategic constituents for achieving resilience in dynamically changing operations
393 environments.

394 Within a turbulent operations environment, to support engineering and ecological
395 resilience in SC management, Eltantawy (2016) recognised the role of endogenous
396 governance capabilities on enhancing SC resilience of buying firms. Furthermore, Aigbogun et
397 al. (2016) investigated the role of Halal logistics on the relation between SC capabilities and
398 vulnerabilities on the resilience of respective pharmaceuticals networks. The statistical
399 analysis of the collected survey data revealed that Halal logistics could mediate the multiple
400 principal-agent relations across the network and thus confer SC resilience, owing to the
401 necessary control and assurance activities to ensure conformity of Halal medications to
402 prescribed standards.

403 From a more focussed view on the shop floor level, for example, the relocation of
404 personnel in tandem with the different attitudes and learning capacities/curves can affect
405 innovation and productivity thus potentially imperilling resilience (De Sanctis et al., 2018). In
406 this vein, Durach and Machuca (2018) recognised the role of interpersonal relationships

407 among employees in buying and supplying firms for improving the resilience efficacy with
408 suppliers. Following the above-mentioned analysis, we have the following:

409 **Finding 3:** *Intrinsic SC resilience refers to the capabilities and mechanisms that guide the*
410 *operations of individual partners, along with their interrelations and coordination*
411 *across the entire network, to respond to disruptions arising internally for*
412 *preventing their propagation and minimising any negative impacts.*

413 3.2.2. Extrinsic Resilience

414 Extending the intra-SC perspective, the structural properties of supply networks that facilitate
415 the mobilisation of resources and adaptability posit an elemental factor in resisting and
416 managing external disturbances (Gilly et al., 2014). Extending this capability-centric notion,
417 resilience shall be viewed as the consequence of political, cultural, and territorial
418 embeddedness of SCs, particularly in developing countries where governance structures
419 might be ineffective (Tukamuhabwa et al., 2017). Furthermore, the selection process of
420 suppliers is essential for the design of resilient SCs that also foster sustainable performance
421 (Mohammed et al., 2021).

422 In addition, global SC operations are being disrupted by negative economic,
423 environmental, and social impacts, like in the food sector where adverse weather conditions
424 often result in food shortages and high price fluctuations (Govindan and Al-Ansari, 2019).
425 Esteves et al. (2012) studied the social impact assessment practice and highlighted the need
426 to (re)connect social impact to resilience and engage with SC management to develop
427 demonstrable value. Therefore, we have the following:

428 **Finding 4:** *Extrinsic SC resilience refers to the capabilities and mechanisms that guide the*
429 *interrelations and operations across network partners to adjust and respond to*
430 *external disruptions for managing any negative impacts on network systems'*
431 *operations and averting the possibility of disruptions' internalisation.*

432 The presented literature analysis documents the multi-dimensional SC governance and
433 resilience character and the need to understand the governing interplay for effective risk
434 management. The key themes that arise in the SC management field have to do with the
435 endogenous and exogenous governance processes and mechanisms to achieve intrinsic and
436 extrinsic resilience in end-to-end operations. Our findings formulate future research agenda
437 by initially recognising the extant gaps and overlaps in the current body of literature.

438 **3.3. Critical Taxonomy**

439 The literature analysis clearly documents the multi-dimensional character and complex
440 nature of SC governance and resilience as well as the challenges that should be addressed at
441 both endogenous/exogenous and intrinsic/extrinsic levels for effective, viable, and
442 sustainable operations. Table 1 presents the resulting critical taxonomy of the systematically
443 reviewed studies. The synopsis of the taxonomised studies is provided in Appendix II. We
444 clarify that the provided taxonomy is by no means an exhaustive list of all relevant studies,
445 but rather acts as a synthesis of the work that has been identified as part of our on-going
446 research.

447 Despite the fact that a plethora of studies exists with regard to the examination of
448 governance, in a range of sectors, there is a lack of holistic approaches for relevant processes
449 and mechanisms to ensure resiliency in SC systems. This gap is particularly notable
450 considering the fact that most of the risks and disruptions are common in the various sectors
451 (e.g., quality issues, climate change).

Table 1. Critical taxonomy of the existing research.

Author(s)	Sector	Method	Theory	SC Resilience (against)	Govern. Body	SC Governance Challenge(s)	SC Govern.		SC Resilience	
							End.	Exo.	Int.	Ext.
1. Ahlqvist et al. (2020)	N.S.	Literature Review	Systems Theory	<ul style="list-style-type: none"> Major incidents impacting critical infrastructures 	SCA	<ul style="list-style-type: none"> Interaction and sharing of resources among SC members 	X		X	
2. Aigbogun et al. (2016)	Pharma	Field Survey	Agency theory	<ul style="list-style-type: none"> Quality assurance errors 	RB	<ul style="list-style-type: none"> Limited flexibility in raw materials' sourcing based on quality standards Complex relations between predictors and outcomes 	X			X
3. Crane et al. (2019)	Food; Construction; Recreational Drugs	Desk-based Study	Global Value Chains	<ul style="list-style-type: none"> Forced labour 	RB	<ul style="list-style-type: none"> Insufficient governance mechanisms to scrutinise both product and labour SCs Myopic focus on global value chains, with domestic SCs being overlooked Limited coordination among governance initiatives, broader regulations and other institutional conditions 		X		X
4. Durach and Machuca (2018)	Mfg.	Structural Equation Modelling	Relational View Theory	<ul style="list-style-type: none"> External shocks Internal shocks 	SCA	<ul style="list-style-type: none"> Governance mechanisms focus on formal inter-organisational relations management and neglect interpersonal relations 	X			X
5. Edgeman and Wu (2016)	N.S.	Critical Discussion	Sustainable Enterprise Excellence, Resilience and Robustness Model	<ul style="list-style-type: none"> External shocks 	SCA	<ul style="list-style-type: none"> Extant strategies and governance mechanisms do not recognise the synergistic relationships and complex interactions in enterprise sustainable innovation systems 	X			X
6. Eltantawy (2016)	N.S.	Conceptual Analysis	Ecological and Engineering Theory	<ul style="list-style-type: none"> Economic shocks Environmental shocks Social shocks 	SCA	<ul style="list-style-type: none"> Risk aversion (i.e., reluctance to invest in new supply management governance forms) Organisational inertia 	X			X
7. Emmanuel-Yusuf et al. (2017)	Energy	Case Study	Value Chain Analysis; Sustainable Livelihood Approach	<ul style="list-style-type: none"> External shocks Internal shocks 	RB; SCA	<ul style="list-style-type: none"> Implementation challenges of internal and external governance policies 	X	X	X	X

Author(s)	Sector	Method	Theory	SC Resilience (against)	Govern. Body	SC Governance Challenge(s)	SC Govern.		SC Resilience	
							End.	Exo.	Int.	Ext.
8. Esteves et al. (2012)	Extractive industries	Critical Discussion	Social impact assessment	• Social shocks	RB	• Understanding the dynamics of change and capacities to respond to change		X		X
9. Gabler et al. (2017)	N.S.	Critical Discussion	Resource-based View; Dynamic Capabilities; Competing Values Theory; SC Governance Theory	• External shocks	RB; SCA	• Increase SC responsiveness and resiliency in a dynamic way		X	X	
10. Kahiluoto et al. (2019)	Agrifood	Principal Component Analysis; Clustering Analysis	Hotspots Analysis	• External shocks	RB	• Responses' diversity against climate-related uncertainty and variability		X	X	X
11. Keck and Etzold (2013)	Food	Case Study	N.S.	• External shocks	RB	• Enabling the development of transformative capacities of food system actors • Allowing access of food system actors to financing instruments • Regulating end-product price fluctuations		X	X	X
12. Khurana et al. (2021)	N.S.	Analytical Hierarchy Process	N.S.	• External shocks	RB	• Allow access to financing instruments • Promote demand for domestic offerings • Foster collaboration between government and industry		X		X
13. Lee et al. (2019)	N.S.	Critical Discussion	N.S.	• External shocks	RB	• Communication and information sharing • Experiences sharing • Resources' allocation		X	X	X
14. Luthe and Wyss (2016)	Tourism	Network Analysis	N.S.	• External shocks	RB	• Prepare for gradual changes by fostering social learning and innovation • React to short-term shocks demanding quick distribution of information and centralised steering of collective action (adaptation)	X	X	X	

Author(s)	Sector	Method	Theory	SC Resilience (against)	Govern. Body	SC Governance Challenge(s)	SC Govern.		SC Resilience	
							End.	Exo.	Int.	Ext.
15. Luthe et al. (2012)	Tourism	Case Study	Social Network Analysis	• External shocks	RB	• Uneven distribution of power and influence due to the core-periphery structure of the network	X	X	X	
16. Luthe and Wyss (2014)	Tourism	Critical Discussion	Social Network Analysis	• External shocks	RB	• Develop collaboration, integration and coordination of each actor's individual resources, activities and services	X	X	X	
17. MacMahon et al. (2015)	Food	Case Study	N.S.	• External shocks	RB	• Poor communication across levels of government		X		X
18. Mancini and Arfini (2018)	Food	Case Study	Convention Theory	• External shocks	SCA	• Emerging market players		X	X	X
19. McKnight (2019)	N.S.	Critical Discussion	Theory of Composition; Theory of Compilation	• External shocks	SCA	• Sustainability challenges	X		X	
20. Meuwissen et al. (2019)	Agriculture	Mixed-methods	Resilience Theory	• Economic shocks • Environmental shocks • Social shocks • Institutional shocks	N.A.	• Sufficient policy arrangements stimulating the three capacities of resilience, i.e., (i) diversity; (ii) stimulating initiative; and (iii) poly-centricity	X	X	X	X
21. Meyer (2020)	Food	Systematic Literature Review	N.A.	• External shocks • Internal shocks	RB	• Quantification of the impact of governance on resilience		X		X
22. Oliver et al. (2018)	Food	Critical Discussion	N.S.	• External shocks	RB; SCA	• Prioritisation of interventions to deliver Sustainable Development Goals	X	X	X	X
23. Pal and Torstensson (2011)	Textile	Principal Component Analysis	N.S.	• Changing market dynamics	SCA	• Mediate operational performance and hence organisational success in a dynamically changing environment	X		X	X
24. Reis (2019)	Food	Literature Review; Interviews	Social Network Theory	• External shocks	RB; SCA	• Formulation of local contingency plans that can support options for meeting food needs during and following a crisis		X		X
25. Schmidt and Matthews (2018)	Food	Critical Discussion	N.S.	• Water, food, energy, climate, and global finance risks	RB	• Interlinking water, energy, food, and climate crises and their ramifications across multiple sites and scales		X		X

Author(s)	Sector	Method	Theory	SC Resilience (against)	Govern. Body	SC Governance Challenge(s)	SC Govern.		SC Resilience	
							End.	Exo.	Int.	Ext.
26. Statsenko et al. (2018a)	Mining	Case Study	Complex Adaptive Systems	• Economic shocks	RB	<ul style="list-style-type: none"> • Multi-layered structure of federal governance systems • Limited understanding of local industry needs • Lack of feedback mechanisms to monitor outcomes 		X		X
27. Statsenko et al. (2018b)	Mining	Case Study	Complex Adaptive Systems	• External shocks	RB; SCA	<ul style="list-style-type: none"> • Complicated industry specifications • Limited shared values and culture is supplier-buyer relations • Low level of collaboration and information sharing among SC actors 	X	X	X	X
28. Vecchi et al. (2020)	Healthcare	Case Study	N.S.	• External shocks	RB	<ul style="list-style-type: none"> • Contractual risks on public procurement • Lack of right skills and access to adequate resources to better assess health organisations' needs and market offerings 		X		X

Symbol: SC – Supply Chain; RB – Regulatory Body; SCA – Supply Chain Actor (meaning private organisation).

454 More specifically, the research on SC governance and resilience is scattered with these
455 concepts being rarely jointly studied. Increasing internal shocks (e.g., quality failures) and
456 external risks (e.g., price fluctuations, extreme weather conditions) put pressure for
457 establishing structured endogenous and exogenous governance processes and mechanisms
458 to enhance SC and systems' resilience. However, multi-faceted governance challenges that
459 transcend global operations necessitate scrutiny over the interplay between SC governance
460 and resilience. The latter interconnections shall be embedded in a more generalised
461 framework since the scant research evidence is clearly case-dependent.

462

463 **4. Supply Chain Governance and Resilience Framework**

464 This section first elucidates the selection of the System Dynamics as an appropriate approach
465 investigates the interplay between SC governance and resilience. Thereafter, literature
466 evidence about the rationalisation and structuring of the proposed conceptual framework is
467 provided. In particular, the framework captures the interplay between SC governance and
468 resilience while then leads to the articulation of a set of propositions for testing by future
469 research efforts.

470 **4.1 System Dynamics Rationalisation**

471 As the notion of SC resilience has to be theorised within a structural and operational dynamics
472 frame (Ivanov and Sokolov, 2019), considering the role of System Dynamics modelling as an
473 explanatory process in networked and collaborative governance (Forliano et al., 2020). We
474 argue that the use of this approach allows the investigation of the underpinning mutual
475 influences, dynamic interrelations, and feedback loops among governance and resilience
476 (Stewart and Ivanov, 2019). System Dynamics, an analytical approach that complements
477 Systems Thinking, is deemed appropriate for studying SC resilience due to the inherent non-
478 linearity of supply network systems and the dynamics of control mechanisms/policies. In fact,
479 System Dynamics has been used in the investigation of the effects of alternative SC structural
480 elements and configurations on disaster response programmes (Besiou et al., 2014). In
481 addition, Spiegler et al. (2016) used System Dynamics to analyse the resilience of a
482 replenishment system against stock-outs in a UK grocery retailer.

483 In this view, System Dynamics enables the consideration and comprehension of non-
484 linear complex systems evolving over time in a systematic manner (Forrester, 1961).

485 Following the notion that SC resilience is within the scope of System Dynamics modelling
486 (Pereira, 2009), while further considering the complexity and the dynamic nature of SC
487 operations, this research captures the structural interdependencies among governance and
488 resilience in a causal loop diagram (CLD).

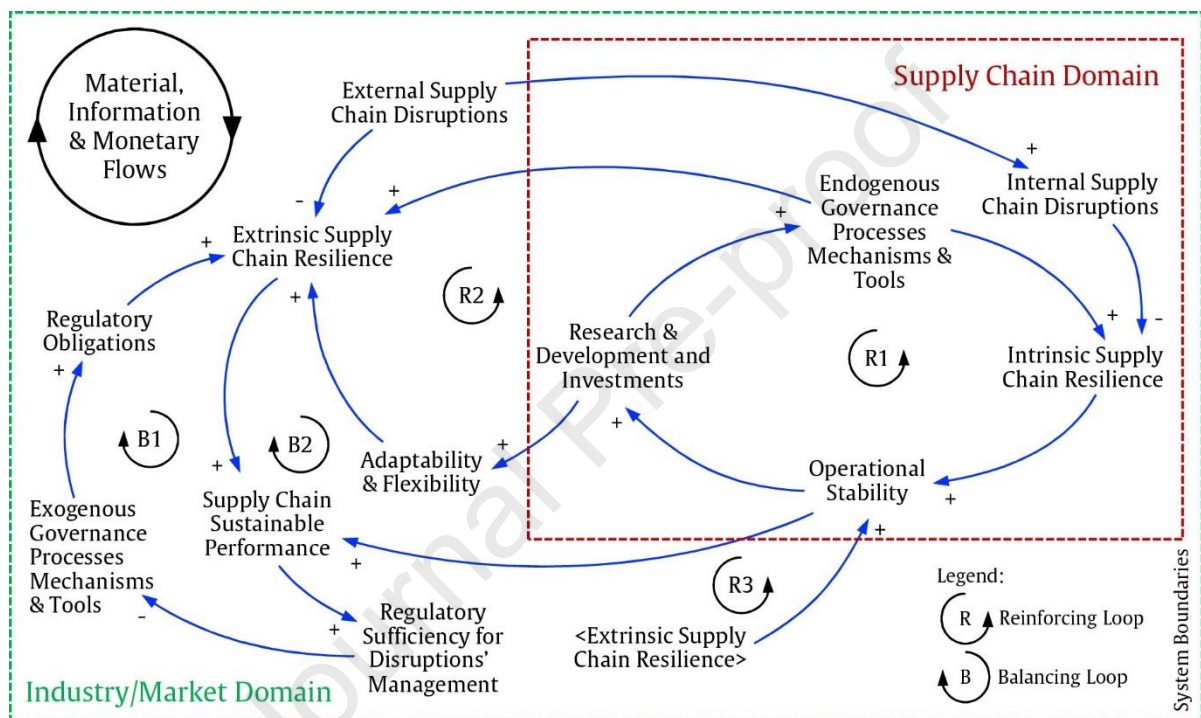
489 **4.2 System Mapping and Conceptual Framework**

490 In the proposed CLD, the complexity and non-linear behaviour underpinning the interrelation
491 between governance and resilience in an SC system are captured via five feedback loops, with
492 each feedback loop capturing a sequence of causes and effects. A change in a particular
493 variable transcends the entire loop (Georgiadis and Vlachos, 2004), ultimately leading to a
494 decrease (i.e., negative polarity symbolised by '-') or increase (i.e., positive polarity
495 symbolised by '+') in the same variable, hence characterising the loop as balancing (denoted
496 as 'B') or reinforcing (denoted as 'R'), respectively. Setting off from the literature findings, we
497 subsequently gathered our thoughts to synthesise what we term as the SC governance and
498 resilience framework, illustrated in the form of CLD. The CLD captures the interplays among
499 all components of SC governance and resilience.

500 Overall, our framework comprises two balancing and three reinforcing loops, which
501 afterwards help inform our research propositions (Figure 4). The system comprises the
502 'Supply Chain Domain' and the 'Industry/Market Domain' where endogenous and exogenous
503 to the SC governance processes and mechanisms are applied, respectively. The consideration
504 of dual-level governance domains is fundamental in the system consideration with similar
505 considerations being documented in other SC areas as well, such as for environmental
506 certification (Stranieri et al., 2021).

507 At the 'Industry/Market Domain', in the indicative balancing loop B1, an enhanced
508 '*Regulatory Sufficiency for Disruptions' Management*' does not motivate the revision and
509 update of '*Exogenous Governance Processes, Mechanisms & Tools*', thus resulting in
510 decreased '*Regulatory Obligations*' to which SC procedures and processes need to adhere to,
511 considering the dynamically changing market conditions and operational environment.
512 Typically, stringent '*Regulatory Obligations*' implies that the SC ultimately demonstrates
513 enhanced '*Extrinsic Supply Chain Resilience*', which in turn leads to improved long-term
514 '*Supply Chain Sustainable Performance*' (Ma et al., 2021).

515 Similarly, in reinforcing loop R1, within the 'Supply Chain Domain', increased '*Research*
 516 *& Development and Investments*' lead to a gamut of improved '*Endogenous Governance*
 517 *Processes, Mechanisms & Tools*' that allow SC actors to develop capabilities (e.g.,
 518 transparency) and respond promptly and effectively to contemporary operational disruptions
 519 thus leading to enhanced '*Intrinsic Supply Chain Resilience*' (Montecchi et al., 2021). Enhanced
 520 resilience entails that the SC demonstrates an elevated '*Operational Stability*'. A list of the
 521 feedback loops is inserted in Table A2 (Appendix III).



522 **Figure 4.** SC governance and resilience interplay: A systems thinking framework.
 523
 524

525 4.3 Research Propositions

526 In the Systems Thinking framework depicted in Figure 4, in the reinforcing loop R1, an increase
 527 in '*Research & Development and Investments*' enables the development and application of
 528 more effective '*Endogenous Governance Processes, Mechanisms & Tools*', ensuring a higher
 529 degree of '*Intrinsic Supply Chain Resilience*'. For example, responses to COVID-19 pandemic
 530 demonstrated that investments in new revenue streams, operational transport flexibility,
 531 digitalisation and data management, logistics infrastructure, and optimised personnel
 532 capacity were pivotal for the resiliency of logistics services providers (Herold et al., 2021).
 533 Except for tangible assets, investments shall also focus on the interpersonal level across all
 534 echelons of operations to develop disruption management skills that sequentially strengthen

535 relational and re-deployable organisational and SC resilience (Durach and Machuca, 2017). In
 536 turn, internal elevated resilience against internal end-to-end supply system's disruptions
 537 entails increased '*Operational Stability*' hence preventing operational failures (Suryawanshi
 538 et al., 2021). This implies that endogenous governance mechanisms impact the intrinsic SC
 539 resilience. Therefore, we put forward our first proposition stating that:

540 **Proposition 1:** *Investments of money, time and effort in novel processes, skills, mechanisms,*
 541 *and tools to better integrate and endogenously govern network operations*
 542 *can help prevent or mitigate the impact of internally arising disruptions thus*
 543 *enhancing the intrinsic SC resilience and operational stability.*

544 In the balancing loop B1, the increased '*Supply Chain Sustainable Performance*'
 545 denotes the current-state '*Regulatory Sufficiency for Disruptions*' *Management*' of the
 546 regulatory landscape within which SC operations unfold (Tsolakis et al., 2018). In addition, the
 547 expansion of operations to international markets necessitates the increased monitoring
 548 requirements of regulatory schemes, thus revealing more '*Exogenous Governance Processes,*
 549 *Mechanisms & Tools*' and the associated increased '*Regulatory Obligations*' such as in the
 550 case of organic food global trade (Esteves et al., 2021). Proactive and timely conformance to
 551 the diverse and ever-changing global and regional boundaries nurture the capability to
 552 persevere the modus operandi thus increasing the '*Extrinsic Supply Chain Resilience*'. For this
 553 reason, we put forward our second proposition as:

554 **Proposition 2:** *On-going monitoring of the global and regional regulatory contexts increases*
 555 *the ability of SCs to recognise necessary adaptations, and the timely and*
 556 *efficient alignment with the diverse exogenous governance arrangements*
 557 *enhances the extrinsic resilience of the supply network.*

558 In the balancing loop B2, '*Extrinsic Supply Chain Resilience*' helps ensure and improve
 559 '*Operational Stability*', which in turn has a supporting role on '*Supply Chain Sustainable*
 560 *Performance*'. To leverage the stability of operations, '*Regulatory Sufficiency for Disruptions*'
 561 *Management*' needs to be an on-going tenet, particularly within the adaptive global
 562 environment of SC operations (Maslin et al., 2019). Thereafter, the realisation of '*Exogenous*
 563 *Governance Processes, Mechanisms & Tools*', depending on the regulatory sufficiency level,
 564 unveils emerging '*Regulatory Obligations*' that improve '*Extrinsic Supply Chain Resilience*'. We
 565 therefore suggest that:

566 **Proposition 3:** *On-going monitoring of the sufficiency of global and regional regulatory*
567 *contexts increases the ability of institutional environments to recognise*
568 *necessary adaptations, and the timely and efficient alignment of the supply*
569 *networks with these diverse exogenous governance arrangements enhances*
570 *their extrinsic resilience.*

571 In the reinforcing loop R2, 'Extrinsic Supply Chain Resilience' advances 'Operational
572 Stability', which subsequently fosters 'Research & Development and Investments' that
573 strengthen the 'Endogenous Governance Processes, Mechanisms & Tools', further improving
574 'Extrinsic Supply Chain Resilience'. For example, motivated by the disruptions in mission-
575 critical supplies due to COVID-19 pandemic, Bhaskar et al. (2020) suggested that a new
576 governance system for interventions by public-health authorities is eminent to reduce
577 inefficiencies and build resilient systems to current and future crises. In this regard, we
578 articulate the following research proposition:

579 **Proposition 4:** *Resilience against the external supply network environment helps ensure*
580 *operational stability and informs initiatives that can subsequently help*
581 *develop endogenous governance processes, mechanisms and tools to*
582 *safeguard operations and improve extrinsic resilience.*

583

584 **5. Concluding Remarks**

585 Black swan events are particularly tricky to predict (Simchi-Levi et al., 2014) yet can have
586 detrimental impacts on operations and SC management. Scholars and practitioners would
587 therefore need to be inspired and, at the same time, be able to provide resolutions to
588 emerging and unprecedented complexities/challenges (Kastanakis et al., 2019). The
589 devastating COVID-19 pandemic is the most recent, notable exemplar of such incidents,
590 which has indicatively disrupted over 80% of SCs in the UK (Hart, 2020). The pandemic has
591 affected all levels of the underpinning conditions and assumptions in SC management systems
592 (Anker, 2021). To improve SC resilience, the emanating disruptions shall be considered from
593 an integral view of SC dynamics (Olivares-Aguila and ElMaraghy, 2021). In this regard, we have
594 unearthed the extant body of literature and we identified inherent typologies of SC
595 governance and resilience, namely endogenous and exogenous governance, and intrinsic and

596 extrinsic resilience. More importantly, we have identified the structural interconnections
597 among the SC governance and resilience constructs/elements.

598 Our research also discovers that SC resilience stems from governance processes,
599 mechanisms, and tools, in a dipole relational system comprising a complex system of
600 interactions. In answering the research questions set out in this study, we observed two
601 emerging themes in which SC governance can be elaborated, that is, those endogenous and
602 exogenous processes, mechanisms and tools, be they currently exist or need to be developed,
603 both externally to the supply network and internally among SC actors. We also confirm, via
604 the proposed framework, the manner in which the governance directly or indirectly impacts
605 the intrinsic and extrinsic resilience of SC operations, demonstrating the interplay of
606 governance and resilience. This will allow a more effective structuring of management
607 directions in a supply network.

608 **5.1. Academic Contributions**

609 In cooperative inter-organisational relationships, like the ones developed across a supply
610 network, relational bonds are more significant for actors (Ring and van de Ven, 2019).
611 However, their relationships are governed by both internal and external to the SC processes,
612 mechanisms, and tools. In this study, we argue that managerial governance impacts SC
613 resilience through a plethora of complex interconnections. For this reason, four research
614 propositions are articulated to elaborate the interplay between SC governance and resilience.

615 Our paper provides implications for theory in several ways. First, backed-up by the
616 relevant literature, this research explicitly acknowledges that SC governance shall be
617 regarded from both endogenous and exogenous perspectives. Though sounded rudimentary,
618 this dichotomy is key in recognising the root causes of risks and the resulting disruptions that
619 can negatively impact the intrinsic and extrinsic resilience of SC operations. To the best of our
620 knowledge, this research is the first to clearly consider and define these typologies, namely:
621 (i) endogenous and exogenous SC governance and (ii) intrinsic and extrinsic SC resilience.

622 Our findings complement the ones from Li et al. (2014) who identified seven internal
623 and external SC factors that affect the (sustainability) governance of decision-making in the
624 fast fashion industry. However, their framework considers only a directed acyclic pathway
625 from goals to decisions. Our research extends this view by considering the dynamic nature of
626 SC governance and resilience. Exogenous governance interests might impose safeguards

627 within SCs via, for example, warranties and monitoring processes. To accommodate
628 adaptations in exogenous SC governance, internal structures, mechanisms, and tools to
629 manage SC actors' relations, capabilities, monetary/information flows, and product and
630 services transactions are required with the aim to mitigate vulnerabilities and foster
631 cooperation.

632 In this regard, the dominant theoretical perspectives in SC governance include the
633 'relational governance' and 'contractual governance'. The 'relational governance' focusses on
634 norms and mechanisms that regulate inter-organisational exchanges (Heide and John, 1992;
635 Lusch and Brown, 1996; Macneil, 1980). In a similar way, 'contractual governance' is rooted
636 on transaction cost economics (Williamson, 1985) and refers to the role of contractual
637 directives to dictate formalities of transactions among trading partners (Lumineau and
638 Malhotra, 2011; Reuer and Ariño, 2007). The scope of these conceptualisations is mainly on
639 avoiding opportunism and conflicts by informing dispute resolution between trading partners
640 (Wathne and Heide, 2004; Williamson, 1996).

641 Second, this research explores the interplay between SC governance and resilience,
642 and embraces the relational view of Dyer and Singh (1998). Using our proposed framework,
643 it is arguably straightforward to observe the circumstances where the alignment of
644 transactions among SC partners requires the appropriate endogenous governance structures.
645 These are proven to be vitally important for sustaining a competitive advantage and
646 increasing the network's intrinsic resilience, against, for example, opportunistic phenomena.

647 Third, our framework implies that a balance between endogenous and exogenous
648 governance processes and mechanisms is required. Specifically, the COVID-19 pandemic
649 revealed congruency between public and private stakeholders' interest towards ensuring
650 higher levels of SC resilience, particularly in the food, pharmaceuticals, and education sectors.
651 Our framework also reveals that endogenous governance can be impacted by exogenous
652 factors, for example, as different cultural and value systems in which foreign actors operate
653 can impact trust-based obligations (Ariño et al., 2001). Vice-versa, in the long-term,
654 endogenous forces can impose changes to the exogenous SC system, particularly in modern
655 markets.

656 **5.2. Managerial Implications**

657 In terms of implications for practice, our proposed framework can explain the causal structure
658 of SC governance and resilience and inform the evaluation of alternative endogenous and
659 exogenous governance options on intrinsic and extrinsic SC resilience. This is in direct support
660 to the development of a transparent-box simulator (Machuca, 1998). The framework can be
661 further programmed into a full-fledged System Dynamics model upon which 'what-if'
662 scenarios can be developed as a basis of enhancing the learning process of decision-makers
663 and SC managers alike.

664 In addition, the provided CLD model and captured system interconnections could
665 guide practitioners to deploy game-based learning engagements and gain a deeper systemic
666 understanding about SC operational challenges (Lainema and Hilmola, 2005). Thereafter, at a
667 managerial level, the output of such a System Dynamics gamification process could help to
668 systematically define a range of practical governance options and operational goals for
669 increasing short- and long-term SC resilience.

670 The proposed framework could be embraced by governmental institutions and
671 organisations to advance decision-makers' participatory interactions and facilitate experts'
672 learning through instigating group conversations (Black, 2013). In this regard, the CLD could
673 act as a well-needed learning-oriented SC exploration and a result-driven exploitation
674 medium within the operational risk management domain (Singh and Hong, 2020).

675 Finally, the framework could be used to guide the policy-level scenario planning by
676 facilitating dynamic analyses of SC disruptions and investigating the responses' outcome
677 based on governance processes and mechanisms already in effect. This is even more
678 prominent for food and pharmaceuticals SCs that require dynamic decision-making in
679 emergency situations, such as the consequent national and regional lockdowns due to the
680 COVID-19 pandemic.

681 **5.3. Limitations**

682 This research has limitations that simultaneously provide stimulating grounds for future
683 studies. First, the proposed Systems Thinking framework was synthesised based on secondary
684 evidence. To this end, applying a group model building method, grounded in the System
685 Dynamics literature (Vennix, 1996; Hovmand et al., 2012), is essential for validation and
686 verification purposes. Second, the framework is sector agnostic. Therefore, it requires
687 validation across multiple sectors and geographical areas as stringent governance regulations

688 are documented to demote resilience like, for example, the stockpiling and environmental
689 regulations in rare earths elements SCs in China (Mancheri et al., 2019).

690 **5.4. Future Research**

691 While this study has provided a theoretical framework with a set of propositions, we are
692 mindful of the need for validation on SC governance and resilience. The need naturally opens
693 up future research avenues to conduct case studies for refining the propositions. We are also
694 keen to apply the computer-based modelling approach, in order not only to visually express
695 the interplay and causality among the constructs in the framework, but also to provide
696 quantitative indications about the strengths of the causality and, indeed, impact. Finally, we
697 are considering conducting empirical research in several SCs in different sectors to learn their
698 idiosyncrasies. This will ultimately help guide the design of more robust SC governance
699 processes, mechanisms to align individual and organisational goals (Zissis et al., 2020), and
700 tools to observe key system constituents that define the systems behaviour and
701 intrinsic/extrinsic resilience.

702

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706

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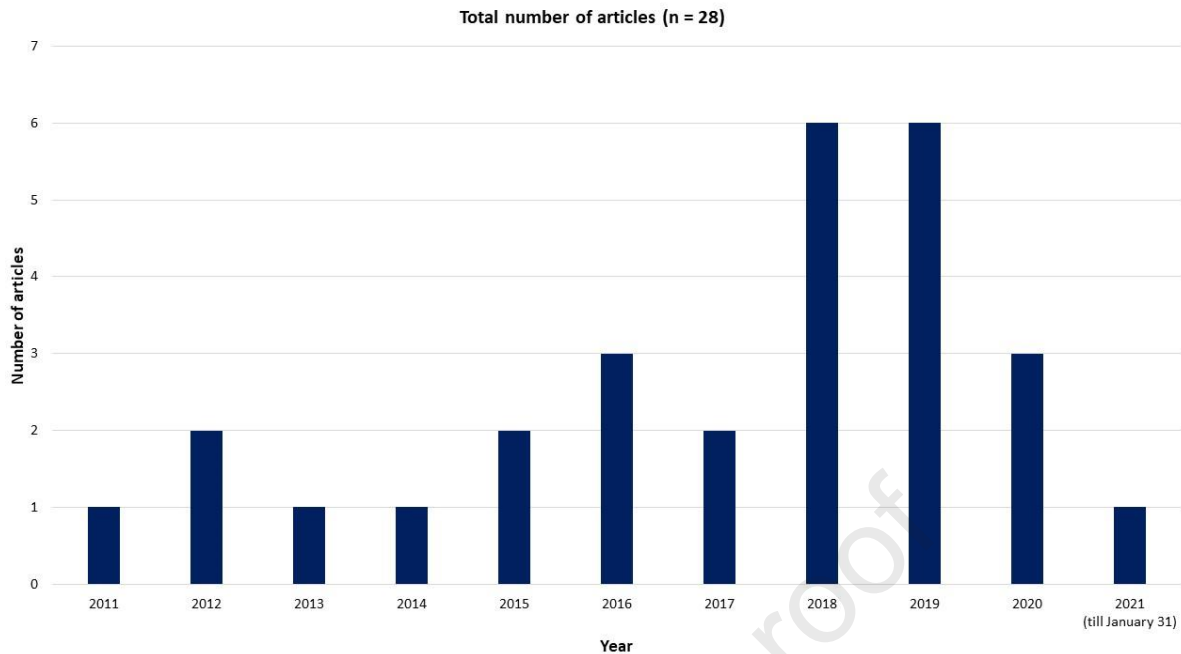
1058 **Appendix**1059 **Appendix I: Overview of taxonomised articles**

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Table A1. List of scientific articles.

Author(s)	Article Title	Journal
1. Ahlqvist et al. (2020)	Supply chain risk governance: Towards a conceptual multi-level framework	<i>Operations and Supply Chain Management</i>
2. Aigbogun et al. (2016)	The mediating impact of Halal logistics on supply chain resilience: An agency perspective	<i>International Review of Management and Marketing</i>
3. Crane et al. (2019)	Governance gaps in eradicating forced labor: From global to domestic supply chains	<i>Regulation and Governance</i>
4. Durach and Machuca (2018)	A matter of perspective – The role of interpersonal relationships in supply chain risk management	<i>International Journal of Operations and Production Management</i>
5. Edgeman and Wu (2016)	Supply chain criticality in sustainable and resilient enterprises	<i>Journal of Modelling in Management</i>
6. Eltantawy (2015)	Towards sustainable supply management: Requisite governance and resilience capabilities	<i>Journal of Strategic Marketing</i>
7. Emmanuel-Yusuf et al. (2017)	Resilience and Livelihoods in Supply Chains (RELISC): An analytical framework for the development and resilience of the UK wood fuel sector	<i>Sustainability</i>
8. Esteves et al. (2012)	Social impact assessment: The state of the art	<i>Impact Assessment and Project Appraisal</i>
9. Gabler et al. (2017)	Disaster resilience through public–private short-term collaboration	<i>Journal of Business Logistics</i>
10. Kahiluoto et al. (2019)	Decline in climate resilience of European wheat	<i>Proceedings of the National Academy of Sciences of the United States of America</i>
11. Keck and Etzold (2013)	Resilience refused wasted potentials for improving food security in Dhaka	<i>Erdkunde</i>
12. Khurana et al. (2021)	Now is the time to press the reset button: Helping India’s companies to become more resilient and effective in overcoming the impacts of COVID-19, climate changes and other crises	<i>Journal of Cleaner Production</i>
13. Lee et al. (2019)	Public–private partnership operational model – A conceptual study on implementing scientific-evidence-based integrated risk management at regional level	<i>Journal of Disaster Research</i>

Author(s)	Article Title	Journal
14. Luthe and Wyss (2016)	Resilience to climate change in a cross-scale tourism governance context: A combined quantitative-qualitative network analysis	<i>Ecology and Society</i>
15. Luthe et al. (2012)	Network governance and regional resilience to climate change: Empirical evidence from mountain tourism communities in the Swiss Gotthard region	<i>Regional Environmental Change</i>
16. Luthe and Wyss (2014)	Assessing and planning resilience in tourism	<i>Tourism Management</i>
17. MacMahon et al. (2015)	Connecting resilience, food security and climate change: Lessons from flooding in Queensland, Australia	<i>Journal of Environmental Studies and Sciences</i>
18. Mancini and Arfini (2018)	Short supply chains and protected designations of origin: The case of parmigiano reggiano (Italy)	<i>Ager</i>
19. McKnight (2019)	The role of firms in resilient systems: A multi-level framework	<i>Canadian Journal of Administrative Sciences</i>
20. Meuwissen et al. (2019)	A framework to assess the resilience of farming systems	<i>Agricultural Systems</i>
21. Meyer, (2020)	The role of resilience in food system studies in low- and middle-income countries	<i>Global Food Security</i>
22. Oliver et al. (2018)	Overcoming undesirable resilience in the global food system	<i>Global Sustainability</i>
23. Pal and Torstensson (2011)	Aligning critical success factors to organizational design: A study of Swedish textile and clothing firms	<i>Business Process Management Journal</i>
24. Reis (2019)	Five things government can do to encourage local food contingency plans	<i>Journal of Environmental Planning and Management</i>
25. Schmidt and Matthews (2018)	From state to system: Financialization and the water-energy-food-climate nexus	<i>Geoforum</i>
26. Statsenko et al. (2018a)	A complex adaptive systems governance framework for regional supply networks	<i>Supply Chain Management</i>
27. Statsenko et al. (2018b)	A supply network governance framework: a case study of the South Australian mining industry	<i>Journal of Global Operations and Strategic Sourcing</i>
28. Vecchi et al. (2020)	Medical supply acquisition in Italy and the United States in the era of COVID-19: The case for strategic procurement and public–private partnerships	<i>American Review of Public Administration</i>



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Figure A1. Distribution of taxonomised articles by year of publication.

1064 **Appendix II: Synopsis of taxonomised articles**

1065 Ahlqvist et al. (2020) conducted an extended literature review and proposed a conceptual
 1066 framework for stressing the role of inter-organisational governance as an enabler of effective
 1067 supply chain (SC) risk management. The proposed multi-level framework describes risk
 1068 governance mechanisms by combining the domains of SC management and risk management
 1069 and societal safety. Aigbogun et al. (2016) conducted a questionnaire-based survey over
 1070 pharmaceutical industry experts and found that Halal logistics mediate the relationship
 1071 between SC capabilities, vulnerabilities, and resilience. In addition, Crane et al. (2019) studied
 1072 secondary evidence from UK-based companies and identified governance gaps in terms of
 1073 forced labour in global value chains. The study findings suggest that to ensure resilience in
 1074 terms of labour, governance initiatives shall consider both the product and labour SC,
 1075 focussing not only on international operations, but also mainly on domestic SCs.

1076 Durach and Machuca (2018) analysed survey data from manufacturing companies in Austria,
 1077 Germany, and Switzerland, and showed that interpersonal skills and complementarity are
 1078 catalysts for firm resilience. Such interpersonal dimensions in buyer–supplier relationships
 1079 impact organisational-level resilience hence indicting the need for setting pertinent
 1080 governance mechanisms. Furthermore, Edgeman and Wu (2016) reviewed the Sustainable
 1081 Enterprise Excellence, Resilience, and Robustness (SEER2) model and discussed that ethical,

1082 efficient, and effective enterprise governance shall be enhanced to respond to challenges
1083 with regard to people, planet and profit sustainability dimensions. The key recognition is that
1084 SC interrelations, and not individual network actors, need to be at the centre of SEER2 and
1085 other relevant models. Eltantawy (2016) conceptually investigated the contrasting aspects of
1086 environmental and economic resilience in SC management. To this effect, the author
1087 proposed a framework that describes governance processes and structures that can enable
1088 supply management engineering and ecological resilience.

1089 Emmanuel-Yusuf et al. (2017) explored the dynamics underpinning socioeconomic benefits
1090 and their impacts on a UK wood-fuel SC resilience and sector growth by developing and
1091 implementing the Resilience and Livelihoods in Supply Chains (RELISC) framework. The
1092 framework's application revealed that socioeconomic benefits, SC resilience, and sectors'
1093 development shall be approached holistically through capturing many system aspects, such
1094 as SC governance and structures, institutional processes and policies, availability of resources,
1095 stakeholders' perceptions and decisions. Additionally, Esteves et al. (2012) discussed the role
1096 of social impact assessment in a changing economic landscape and commented the need of
1097 institutional governance responses for ensuring social and environmental resilience. In this
1098 regard, the study also highlighted the need for social performance management in SCs for the
1099 welfare of all involved stakeholders. Gabler et al. (2017) realised the dynamic complexity of
1100 relationships pertaining disaster SC management and suggested short-term collaborations
1101 among public and private organisations for disaster resilience.

1102 Kahiluoto et al. (2019) used statistical analyses to investigate the resilience of staple food
1103 crops in major European countries against climatic variability. The study findings suggested
1104 that national action plans and the Common Agricultural Policy of the European Union shall
1105 consider the dynamic changes in climatic conditions by incentivising SCs to leverage
1106 complementary responses to critical weather events thus enhancing the resilience of
1107 cropping systems and food security. In a similar vein, Keck and Etzold (2013) discussed
1108 Dhaka's food system and pinpointed the role of food network actors in ensuring system's
1109 resilience under ecological, economic and political crises. The study highlighted the catalytic
1110 role that central governance can have in enabling the transformative capacities of regional
1111 food systems' actors for ensuring food system and social resilience against disturbances, such
1112 as production disruptions (e.g., adverse weather conditions) and prices' fluctuations. More
1113 recently, Khurana et al. (2021) identified and prioritised essential factors that can help

1114 companies to overcome crises, by examining the case of India at the outbreak of COVID-19
1115 pandemic. Through analytic hierarchy process (AHP) analysis, the study findings revealed the
1116 factors that can help companies to improve their resilience in post-crises eras; the 'Role of
1117 governance' found to be the most important of these factors. Lee et al. (2019), motivated by
1118 natural disasters in Asia, discussed that disaster resilience and SC integrity can be achieved
1119 through innovative technologies and collaboration on information sharing, resources'
1120 allocation and risks' communication/awareness among stakeholders in public-private
1121 partnerships, across different regions.

1122 Luthe et al. (2012) investigated the social processes of governance and their impact on
1123 resilience towards climate change, through conducting a social network analysis to the
1124 tourism industry-dependent Swiss Gotthard region. The study findings indicated that to
1125 increase regional resilience to climate change, mechanisms are required that ensure
1126 economic diversification and a governance network structure for stability, flexibility, and
1127 innovation. Similarly, Luthe and Wyss (2014) viewed tourism systems as interrelated social-
1128 economic-ecological systems where network governance is required to: (i) prepare for
1129 disturbances through decentralised processes of social learning and (ii) respond to
1130 disturbances via ensuring flexibility through centralised collective action. Such governance
1131 provisions could increase the capacity of tourism systems to ensure resilience against
1132 disruptions, such as climate change and economic crises. What is more, Luthe and Wyss
1133 (2016) studied the resilience of tourism systems to climate change, at both regional and local
1134 levels. In particular, through a network analysis of primary data, the authors concluded that
1135 to ensure resilience of the Swiss Surselva-Gotthard tourism socio-economic system against
1136 climate change, a network governance perspective is required at different scales. Governance
1137 shall foster social learning and innovation to prepare for gradual changes and enable
1138 adaptability to respond to short-term shocks that demand quick distribution of information
1139 and centralised steering of collective action.

1140 MacMahon et al. (2015) studied the resilience of the food supply system in the Australian
1141 state of Queensland, in the post-flooding of 2010/2011. The observations revealed that
1142 resilience to climate change should be an inclusive concept focussing on not only business
1143 continuity and community self-sufficiency, but also considering adaptation, learning,
1144 relationship-building, and social well-being as well. In addition, the study revealed that
1145 important food security actors are often excluded from decision-making about governance

1146 responses to disruptions. Mancini and Arfini (2018) studied the short food SC of the
1147 Parmigiano Reggiano cheese along with its governance for improved resilience during the
1148 economic crisis era 2007-2012. The governance of the Parmigiano Reggiano SC, and of other
1149 Protected Designation of Origin products, is complex as it involves multiple internal and
1150 external stakeholders. However, such a complex governance proved to be necessary for the
1151 economic, social and environmental sustainability of local food production systems under
1152 global market pressures. Also, McKnight (2019) argued that inter-firm practices of self-
1153 governance and interdependencies, along with SC collaboration, are antecedents of network
1154 system resilience in terms of sustainability.

1155 Meuwissen et al. (2020) developed a framework for evaluating and operationalising resilience
1156 in European farming systems. The authors applied a mixed-methods approach on the arable
1157 farming system in Veenkoloniën, the Netherlands, and recognised the need to ensure
1158 governance adaptability at both the policy-making and farm levels to foster resilience. Meyer
1159 (2020) systematically reviewed the literature on food system resilience in low- and middle-
1160 income countries and highlighted the need to quantifying resilience to analyse the impact of
1161 transformation in terms of sustainable outcomes and food security. The author noted that
1162 extant studies do not typically evaluate the impact of governance on food systems' resilience
1163 while a systems perspective is required to consider the resilience implications of global
1164 governance on regional settings. Oliver et al. (2018) discussed the global food system and
1165 observed that governance at all levels is needed to improve the resilience of food SCs and
1166 deliver multiple UN Sustainable Development Goals.

1167 Pat and Torstensson (2011) considered organisations as complex adaptive systems and
1168 explored the role of three-dimensional concurrent engineering on devising and sustaining
1169 critical success drivers for improved operational performance and organisational profitability.
1170 Through investigating Swedish textile and clothing firms, the authors identified intangible
1171 value propositions, such as organisational culture, leadership, and governance as pivotal
1172 design elements for organisational resilience in dynamic market environments. Reis (2019)
1173 investigated the food supply network in the Australian regional context of South-East
1174 Queensland and focussed on supply disruptions due to extreme weather conditions. Through
1175 a literature review and experts' engagement, the author articulated policy recommendations
1176 for developing food-related disaster resilience at a community level.

1177 Moreover, Schmidt and Matthews (2018) examined the role of global financial networks in
 1178 promoting the governance and security of water, energy, food, and climate. Through a critical
 1179 analysis of the literature, the authors stressed that governing the interlink among water,
 1180 energy, food, and climate crises, across multiple sites and scales, can propel the resilience of
 1181 environmental and economic systems. Statsenko et al. (2018a) studied the combined effect
 1182 of regional SCs and governance to the economic resilience of regions. Based on empirical
 1183 research on the South Australian mining sector, the authors proposed a governance
 1184 framework highlighting the role of formal (i.e., regulations, incentives, programmes) and
 1185 informal (i.e., social norms, trust, reputation) supply network system governance to foster
 1186 regional SC structure and connectivity for facilitating technology and knowledge diffusion,
 1187 thus promoting resilience of the regional economy. Statsenko et al. (2018b) also stressed the
 1188 need for policy-makers and industry stakeholders to undertake initiatives for increasing
 1189 connectivity among business actors in the mining industry of South Australia to propel the
 1190 adaptability, responsiveness and resilience of the regional supply network. Finally, Vecchi et
 1191 al. (2020) investigated the resiliency of the procurement system of materials in the COVID-19
 1192 era, via examining the cases of Italy and the US. The authors stressed the need for public
 1193 governance entities to co-design procurement systems with business stakeholders and shift
 1194 the focus from a compliance-based perspective to a risk management and collaborative
 1195 perspective.

1196 **Appendix III: Feedback loops**

1197 **Table A2.** Structure of the feedback loops of the conceptual framework.

Feedback Loop	Causal Effect Sequence
Reinforcing, R1	Operational Stability → Research & Development and Investments → Endogenous Governance Processes, Mechanisms & Tools → Intrinsic Supply Chain Resilience → Operational Stability
Reinforcing, R2	Operational Stability → Research & Development and Investments → Endogenous Governance Processes, Mechanisms & Tools → Extrinsic Supply Chain Resilience → Operational Stability
Reinforcing, R3	Operational Stability → Research & Development and Investments → Adaptability & Flexibility → Extrinsic Supply Chain Resilience → Operational Stability
Balancing, B1	Extrinsic Supply Chain Resilience → Supply Chain Sustainable Performance → Regulatory Sufficiency for Disruptions' Management → Exogenous Governance Processes, Mechanisms & Tools → Regulatory Obligations → Extrinsic Supply Chain Resilience

Balancing, B2 Operational Stability → Supply Chain Sustainable Performance → Regulatory Sufficiency for Disruptions' Management → Exogenous Governance Processes, Mechanisms & Tools → Regulatory Obligations → Extrinsic Supply Chain Resilience → Operational Stability

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Journal Pre-proof