



HELLENIC
OPEN
UNIVERSITY

Stefania Pappa, Supply Chain Resilience: A systematic literature review



HELLENIC
OPEN
UNIVERSITY

School of Social Sciences

Supply Chain Management (SCM)

Postgraduate Dissertation

Supply Chain Resilience: A systematic literature review

Stefania Pappa

Supervisor: Michail Pazarskis

Patras, Greece

January 2024

Theses / Dissertations remain the intellectual property of students (“authors/creators”), but in the context of open access policy they grant to the HOU a non-exclusive license to use the right of reproduction, customization, public lending, presentation to an audience and digital dissemination thereof internationally, in electronic form and by any means for teaching and research purposes, for no fee and throughout the duration of intellectual property rights. Free access to the full text for studying and reading does not in any way mean that the author/creator shall allocate his/her intellectual property rights, nor shall he/she allow the reproduction, republication, copy, storage, sale, commercial use, transmission, distribution, publication, execution, downloading, uploading, translating, modifying in any way, of any part or summary of the dissertation, without the explicit prior written consent of the author/creator. Creators retain all their moral and property rights.



Supply Chain Resilience: A systematic literature review

Stefania Pappa

Supervising Committee

Supervisor:

Michail Pazarskis

Associate Professor

Department of economics

Hellenic Open University

Co-Supervisor:

Sikalidis Alexandros

Assistant Professor (elected)

Department Accounting and Finance

University of Macedonia

Patras, Greece

January 2024

“My family and loved ones who supported me throughout.”

Abstract

Purpose – The COVID-19 pandemic's global expansion has had a substantial impact on supply networks. Since the start of the pandemic, numerous studies have been published on the various supply-chain difficulties caused by COVID-19. However, despite the ongoing increase in the number of studies on this topic, a lack of comprehensive literature reviews has left questions about which elements have been adequately studied and which areas deserve further investigation. Therefore, the objective of this study is to deep dive into how the research has been developed over the past years and shed light on future prospects. The onset of the COVID-19 pandemic provided a distinctive opportunity to scrutinize the literature for this topic and highlighted more than ever how crucial it is for the companies to enhance and focus on building resilient supply chains.

Design/Methodology/Approach – This thesis provides a systematical review of existing literature research on SCR. Only articles that are available in Scopus database are included, using the keyword “supply chain resilience”, in EU countries. The search strategy resulted in 974 studies and after applying relevant filters and doing the necessary quality checks, as primary papers relevant to this research, 37 articles were identified.

Findings – Based on the SLR that we have conducted we concluded that publications have increased significantly (from 2 in 2019 to 15 in 2023). COVID-19 pandemic is characterized as a turning point and highlighted more than ever how important it is to have a resilient supply chain that can adjust rapidly when interruptions occur. The synthesis of the findings show that published work is focused primarily on the effects of the COVID-19 pandemic. Moreover, innovative concepts as well as strategies for resilience capacity are analyzed. Lastly, how resilience strategies are implemented, and the role of information technology are some other core findings of this SLR.

Originality/value – This thesis covers the gap in current literature, shows the effect of the pandemic and proposes future directions.

Keywords

Supply chain resilience, Resilient supply chain, COVID-19

Η Ανθεκτικότητα της Εφοδιαστικής Αλυσίδας: Συστηματική Βιβλιογραφική Ανασκόπηση

Στεφανία Παππά

Περίληψη

Σκοπός - Η εξάπλωση της πανδημίας COVID-19 έχει επηρεάσει σημαντικά τις αλυσίδες εφοδιασμού. Από την αρχή της πανδημίας, έχουν δημοσιευθεί πολλές μελέτες για τα διάφορα ζητήματα που εγείρονται από την COVID-19 σχετικά με την εφοδιαστική αλυσίδα. Ωστόσο, ενώ ο αριθμός των άρθρων για αυτό το θέμα αυξάνεται σταθερά, λόγω του μικρού αριθμού συστηματικών ανασκοπήσεων βιβλιογραφίας, παραμένει ακόμη ασαφές ποιες πτυχές αυτής της διαταραχής έχουν ήδη μελετηθεί και ποιες πτυχές πρέπει να διερευνηθούν περαιτέρω. Έτσι, η εργασία αυτή στοχεύει στο να εμβαθύνει στην ερευνητική ανάπτυξη στην ανθεκτικότητα της εφοδιαστικής αλυσίδας, να δείξει πώς έχει εξελιχθεί τα τελευταία χρόνια και τι επιφυλάσσει το μέλλον. Το ξέσπασμα της πανδημίας COVID-19 ήταν μια μοναδική ευκαιρία για τη διερεύνηση της βιβλιογραφίας για αυτό το θέμα και τονίστηκε περισσότερο από ποτέ πόσο σημαντικό είναι για τις εταιρείες να ενισχύσουν και να επικεντρωθούν στη δημιουργία ανθεκτικών αλυσίδων εφοδιασμού.

Σχεδιασμός/Μεθοδολογία/Προσέγγιση – Η παρούσα εργασία εξετάζει συστηματικά την υπάρχουσα έρευνα σχετικά με την ανθεκτικότητα της εφοδιαστικής αλυσίδας. Η ανάλυση πραγματοποιείται μόνο σε άρθρα της βάσης δεδομένων Scopus με τις λέξεις-κλειδιά «ανθεκτικότητα εφοδιαστικής αλυσίδας», σε χώρες της Ε.Ε. Η στρατηγική αναζήτησης οδήγησε σε 974 μελέτες, από τις οποίες οι 37 αναγνωρίστηκαν ως πρωτογενείς εργασίες σχετικές με αυτήν την έρευνα.

Ευρήματα – Με βάση την ανασκόπηση που έχουμε πραγματοποιήσει, καταλήξαμε στο συμπέρασμα ότι οι δημοσιεύσεις έχουν αυξηθεί σημαντικά (από 2 το 2019 σε 15 το 2023). Το

Postgraduate Dissertation

ξέσπασμα της πανδημίας COVID-19 σηματοδοτείται ως σημείο καμπής και τόνισε περισσότερο από ποτέ τη σημασία της ύπαρξης μιας ανθεκτικής αλυσίδας εφοδιασμού που μπορεί να προσαρμοστεί γρήγορα σε διαταραχές. Η σύνθεση των ευρημάτων καταδεικνύει ότι το κύριο επίκεντρο της σχετικής έρευνας βρίσκεται στις επιπτώσεις της πανδημίας COVID-19, στις νέες έννοιες και στρατηγικές ικανότητας για ανθεκτικότητα και στον αναδυόμενο ρόλο ψηφιακής τεχνολογίας στην εφαρμογή στρατηγικών ανθεκτικότητας.

Πρωτοτυπία/αξία – η παρούσα εργασία καλύπτει το κενό στην τρέχουσα βιβλιογραφία, δείχνει την επίδραση της πανδημίας COVID-19 και προτείνει μελλοντικές ερευνητικές κατευθύνσεις.

Λέξεις – Κλειδιά

Ανθεκτικότητα της εφοδιαστική αλυσίδας, Ελαστικότητα εφοδιαστικής αλυσίδας, Πανδημία, COVID-19

Table of Contents

Abstract	ii
Περίληψη	iv
Table of Contents	vi
List of Figures	vii
List of Tables	viii
List of Abbreviations & Acronyms.....	ix
1. Introduction.....	1
2. Methodology: a systematic literature review	4
2.1 Definition of SCR in the literature	4
2.2 The SLR method	4
2.3 The SLR search strategy.	6
3. Results.....	9
3.1 RQ1: What is the current status of research.....	9
3.1.2 Geographic area(s).....	14
3.1.3 Number of authors.....	15
3.2 RQ2: What are the key points & contents of the literature in supply chain resilience ..	17
3.2.1. Methodologies used	17
3.2.2 Theories.....	20
3.3 RQ3: What are the opportunities for future research?	23
3.3.1 Recommendations based on RQ1 and RQ2 assessment.....	23
3.3.2 Recommendations using the most cited articles.....	24
4. Conclusion	30
4.1. Closing remarks	30
4.2 Limitations	31
4.3 Directions for future research	32
References.....	33
Postgraduate Dissertation	

List of Figures

Figure 1. Protocol for systematic literature review

Figure 2. SLR search strategy

Figure 3. Resulting database query for the Scopus database.

Figure 4: Annual number of publications

Figure 5. Articles per journal

Figure 6. Methodological categories used in reviewed articles

Figure 7. Supply chain resilience hierarchy

List of Tables

Table 1. Articles per publisher

Table 2. Results of the first research question

Table 3. Number of articles per country

Table 4. Articles per author

Table 5. Number of countries of origin per article

Table 6. Specific research methods used in reviewed articles

Table 7. Indicative impact of the most cited articles

Table 8. Top-ten cited studies based on CPY (citations per year)

List of Abbreviations & Acronyms

BC	Blockchain Technology
BN	Bayesian networks
CPY	Citations per year
ISN	Intertwined Supply Network
MCDM	Multi-criteria decision-making
SC	Supply Chain
SCR	Supply Chain Resilience
SCRM	Supply Chain Risk Management

1. Introduction

Over the last decade, supply chain managers and researchers have been increasingly interested in sustainability and resilience. While achieving long-term competitive advantages remains a top priority, resilience has grown in importance within supply chains. Moreover, significant transformations in supply chains have been documented globally as a result of increased globalization and innovation rates. While supply chains demonstrate efficiency in stable environments, they also exhibit heightened vulnerability to risks and disruptions (Kamalahmadi & Parast, 2015). Ponomarov et al. 2009, define supply chain resilience as the supply chain's ability to be prepared for unforeseen events, react to disruptions, and recover from them while remaining operational at the desired level (Kamalahmadi & Parast, 2015). The recovery from unanticipated supply chain disruptions, the restoration or even the improvement of its original performance are the supply chain's main purpose. (Hohenstein, Feisel, & Hartmann, 2014; Sheffi & Rice, 2005).

Natural disasters like floods and earthquakes, as well as threats like labor strikes and terrorist attacks, can affect supply chain operations. Simultaneously, the supply chain must confront and remain resilient to recent trends, such as increased competition, tighter regulations, and consumer pressures, (Meixell & Luoma, 2015), outsourcing, uncertainty in demand, globalization, shorter product life cycles and an increasing innovation rate. The performance of the SC is impacted by supply chain disruptions, which has an effect on the planning parameters and the structural design of the SC. In literature this phenomenon is frequently referred to as the domino or ripple effect, which signifies that a disruption is not limited to a specific part of the SC but has an impact on overall SC performance. Based on (Dolgui, Ivanov, & Sokolov, 2017) "the ripple effect refers to low frequency but high impact disruptions or extraordinary risks".

The outbreak of the pandemic in 2019, maybe has been the least common, but most severe, supply chain disruption that has ever been documented in history. Both demand and supply within supply chains were impacted, resulting in a massive ripple effect that has been affected in depth the majority of economic sectors (Carissimi, Prativiera, Creazza, Melacini, & Dallari, 2022). Delivery delays, drop in service level, fluctuating customer demand, sales and market share losses are some of the issues that the companies experienced. (Spieske & Birkel, 2021).

COVID-19 differed from previous disruptions, its effects were severe and multiple, but unpredictable. According to the literature regarding supply chain risk management (SCRM), a global pandemic was thought to be an unlikely to happen event (Spieske & Birkel, 2021).

An established choice for achieving SC vulnerability is resilience. Supply chain resilience can be achieved by establishing a wide range of strategies. The main broad categories can be identified as following (Ivanov, Dolgui, Sokolov, & Ivanova, 2017):

- (1) redundancy: build back up plans/alternatives and have extra resources in case they are needed (examples: safety stock, maintain raw materials, increase inventory);
- (2) flexibility: ability to change abruptly by changing the SC configuration;
- (3) agility: alter the operating states quickly and cost efficiently when needed;
- (4) collaboration: work closely with SC partners with transparency and create strong partnerships for mutual benefit;
- (5) innovation: digitalization and transformation of procedures and processes.

In addition to all the above mentioned, it is critical for businesses to establish a set of strategies that generate resilience over its phases: (i) before-disruption, meaning to predict probable disruptions and develop mitigation methods to reduce the impact (risk identification, strong connections), (ii) during-disruption, meaning the ability to respond and to recover quickly and efficiently when a disruptive event occurs, (iii) after-disruption, meaning the ability to recover fast and also strengthen the supply chain resilience to be ready to confront future disruptions (Carissimi, Pratavia, Creazza, Melacini, & Dallari, 2022).

Based on the above consequences, SCR is at the center of attention. In this context, we conducted a systematic literature review (SLR) in order to examine the current research state and outline future research opportunities. This will help researchers to avoid contacting repetitive research in this area. A systematic literature review is instrumental in consolidating our understanding of what is known, how this knowledge has been acquired, and what can be explored in the future. It can also be used as a base in order to start corporate research and development, to produce outcomes that can help companies deal better with the impacts of unforeseen disruptions.

In our study, we will answer to the following research questions aiming to advance the supply chain resilience literature: a) What is the current status of research; b) What are the key points

& contents of the literature in supply chain resilience and c) What are the opportunities for future research.

This paper is structured as follows: Section 2 contains the review methodology of the systematic literature review. Section 3 contains in detail analysis of the selected bibliography and also an attempt to map the research questions and explore outcomes. Lastly, in section 4 we present our results, suggesting future directions and research topics that can be further explored.

2. Methodology: a systematic literature review

The major goal of our SLR is to evaluate the present status of the existing literature on SCR. This literature review has been meticulously consolidated using a clear process to define relevant research keywords, to review the corresponding published work, to analyze data and discuss potential research opportunities for the future.

2.1 Definition of SCR in the literature

The term resilience was first used in engineering, to characterize the resistance of materials. Then, in his article in 1973, Holling, introduced the concept of resilience in an ecological context. The idea of resilience was originally utilized in studies between 1998 and 2003, although there was no clear definition (Gokhale A. A., 1998). Around 2004, the first definition was formed in literature and later expanded. More specifically, it is referring to the ability of a SC to adapt and re-initialize its operations, but also has as prerequisite the re-initialized state to be “better than the initial” (Ponomarov & Holcomb, 2009). Resilience theory is founded on engineering finding; hence it is considered to be a phenomenon that can be found in physical research and also in management theory (Castillo, 2023).

Last but not least, it is noteworthy that upon assessing the outcomes presented in the literature regarding the supply chain resilience, we have noticed two periods: the pre-pandemic area, and the post-pandemic area.

2.2 The SLR method

Based on the structure proposed by Tranfield et al., (2003), we designed the review technique of this dissertation. In order to eliminate research bias, this structure has been applied in several SLR studies, in various contexts. The review technique and its respective steps are depicted in Figure 1.

Our systematic literature process is divided into 3 main categories:

1. Planning of the review: in this step we define the scope of the SLR and the research questions that the SLR will answer.
2. Conducting the review: this step includes databases identification, article screening and quality assessment in order to find the final articles that will be analyzed in SLR.
3. Reporting & dissemination: we draw conclusions and discuss the findings of the SLR.

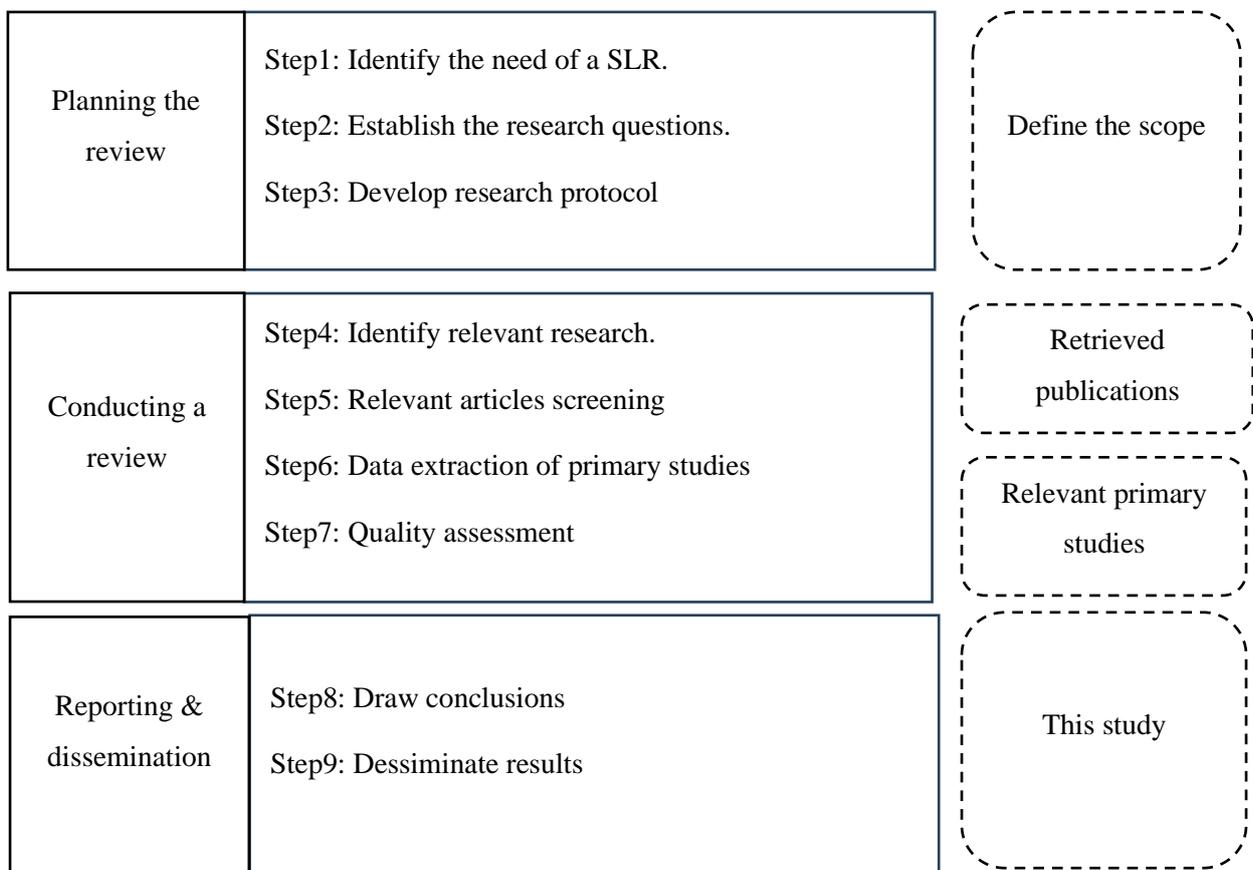


Figure 1. Protocol for systematic literature review

2.3 The SLR search strategy.

<p>Research questions:</p> <p>RQ1: What is the current status of research.</p> <p>RQ2: What are the key points & contents of the literature in supply chain resilience.</p> <p>RQ3: What are the opportunities for future research.</p>
<p>Identified database: Scopus.</p> <p>Keywords: Supply chain resilience & resilient supply chain: 974</p> <p>Exclude papers/chapters and articles that are in other language than English: 667</p> <p>Publication stage “final”: 558</p> <p>Include articles that are open access: 277.</p> <p>Include only the articles that the affiliation country is in the European Union: 95.</p> <p>AJG list: only 3+4+4*: 69 articles</p> <p>Read articles in their entirety exclude duplicated & irrelevant: 37</p>
<p>Data extraction: Author(s), Title, Publication Year, Journal, Subject Area, Volume, Citations in Scopus, Abstract, Keywords, Publisher, Country, Theory, Data collection method.</p> <p>Analysis and results</p> <p>Conclusion future research recommendations</p>

Figure 2. SLR search strategy

As described in Figure 2, we selected the Scopus database as a source for the research publications to obtain and analyze. Scopus is considered to be the most extensive database for management-, as well as engineering-focused academic journal articles (Zamani, Smyth, Gupta, & Dennehy, 2023). We used the keywords “supply chain resilience” and “resilient supply chain”, which procured a total of 974 articles. Then, the document type category to “articles” and excluded the results whose primary language was not English. With these steps,

the number of articles was reduced to 667. Then, we excluded the articles that were not in the final publication stage, and we resulted in a total of 558 articles. By selecting only open access articles, 277 were procured. Lastly, we chose the articles whose affiliation country was a member of the European Union and the number of total articles dropped to 95.

For this SLR we decided to add an extra parameter: the journal that the article is published in. The reason for this decision was that we desired to keep only the top ranked journals, so we used the “Academic Journal Guide” category - popularly known as ABS List. The AJG is a guide to the quality and range of publications in the area of Business and Management academic research. It ranks Business and Management Journals on a scale of 1 to 4*, the 4* indicates the highest-ranked titles. Consequently, from this list, we selected journals that ranked with 3, 4 or 4* in 2021, dropping the total number of articles to 69.

As a last step to the whole process, we did a quality assessment check and read the article contents in their entirety. We excluded the duplicates and irrelevant articles, so we ended up with 37 articles.

The filters mentioned in the above process, once applied, result in a machine-readable query that is executed over the Scopus database. The resulting query is shown below in Figure 3:

```
TITLE-ABS-KEY ( "supply chain resilience*" ) AND ( LIMIT-TO ( EXACTKEYWORD , "Supply Chain Resilience" ) OR LIMIT-TO ( EXACTKEYWORD , "Supply Chain Resilience (SCR)" ) OR LIMIT-TO ( EXACTKEYWORD , "Supply Chain Resiliences" ) OR LIMIT-TO ( EXACTKEYWORD , "Resilient Supply Chain" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( OA , "all" ) ) AND ( LIMIT-TO ( AFFILCOUNTRY , "Austria" ) OR LIMIT-TO ( AFFILCOUNTRY , "Belgium" ) OR LIMIT-TO ( AFFILCOUNTRY , "Czech Republic" ) OR LIMIT-TO ( AFFILCOUNTRY , "Cyprus" ) OR LIMIT-TO ( AFFILCOUNTRY , "Denmark" ) OR LIMIT-TO ( AFFILCOUNTRY , "Finland" ) OR LIMIT-TO ( AFFILCOUNTRY , "France" ) OR LIMIT-TO ( AFFILCOUNTRY , "Germany" ) OR LIMIT-TO ( AFFILCOUNTRY , "Greece" ) OR LIMIT-TO ( AFFILCOUNTRY , "Hungary" ) OR LIMIT-TO ( AFFILCOUNTRY , "Ireland" ) OR LIMIT-TO ( AFFILCOUNTRY , "Italy" ) OR LIMIT-TO ( AFFILCOUNTRY , "Netherlands" ) OR LIMIT-TO ( AFFILCOUNTRY , "Poland" ) OR LIMIT-TO ( AFFILCOUNTRY , "Portugal" ) OR LIMIT-TO ( AFFILCOUNTRY , "Slovakia" ) OR LIMIT-TO ( AFFILCOUNTRY , "Spain" ) OR LIMIT-TO ( AFFILCOUNTRY , "Sweden" ) )
```

Figure 3. Resulting database query for the Scopus database.

After executing the query, the result set that is then downloaded in a tabular format contains a set of fields (columns). These are: the Author(s), Database(s), Abstract, Year of Publication, Journal, Subject Area(s), Country(-ies), Research Theme examined, Volume, DOI, Author Keywords, Indexed Keywords and the Citations.

The list of papers reflected different publishers, including Elsevier¹, Emerald², Taylor and Francis³, Springer⁴, John Wiley and Sons⁵ and Institute of Electrical and Electronics Engineers Inc⁶. Elsevier specializes in scientific, technical, and medical content, publishing the most papers with 13/37 (35%). Emerald, focuses in areas of social sciences and management, business, education and library studies but also areas of health, sciences, technology and engineering. Emerald published 10/27 (27%). Taylor and Francis focused in areas of humanities, behavioural science, social science, law, technology, science, engineering and mathematics, medicine published 6/27 (16%), Springer specialized in Science, technology, medicine, business, transport and architecture and published 4/27 (11%), John Wiley and Sons focuses in Science, technology, medicine, professional development, higher education published 3/27 (8%), Institute of Electrical and Electronics Engineers specializes in Electrical, electronics, communications, and computer engineering and published 1/27 (3%).

Publishers		
Elsevier	13	35%
Emerald	10	27%
Taylor and Francis	6	16%
Springer	4	11%
John Wiley and Sons	3	8%
Institute of Electrical & Electronics Engineers Inc.	1	3%
Total	37	100%

Table 1. Articles per publisher

¹ <https://www.sciencedirect.com/>

² <https://www.emerald.com/insight>

³ <https://www.tandfonline.com>

⁴ <https://link.springer.com>

⁵ <https://www.wiley.com/en-ie>

⁶ <https://ieeexplore.ieee.org/Xplore/home.jsp>

Postgraduate Dissertation

3. Results

In this section we analyze the methodologies, contexts, and theoretical foundations identified in the 37 publications selected by using the process described in Section 2.

3.1 RQ1: What is the current status of research.

The purpose of this study is to gather and improve our current understanding of supply chain resilience. More specifically, the primary goal is this first question is to get more insights on the field's history and see the evaluation that has been performed until now. This will be used as guidance to researchers and academics in their journey of identifying the importance of supply chain resilience.

The number of publications per year in Scopus from 2015 to 2023 is shown in Figure 4. The number of studies has been climbing after 2021 and has reached a peak of 15 articles in 2023. This suggests that researchers examined and analyzed the supply chain resilience after the passing of the COVID-19 pandemic. After reviewing the articles published in Scopus, it is evident that 2023 was a turning point in research regarding supply chain resilience. A valid assumption would be that the articles published in 2023 started in 2022 and 2021 during the spread of the pandemic, when supply chains around the globe were already affected.

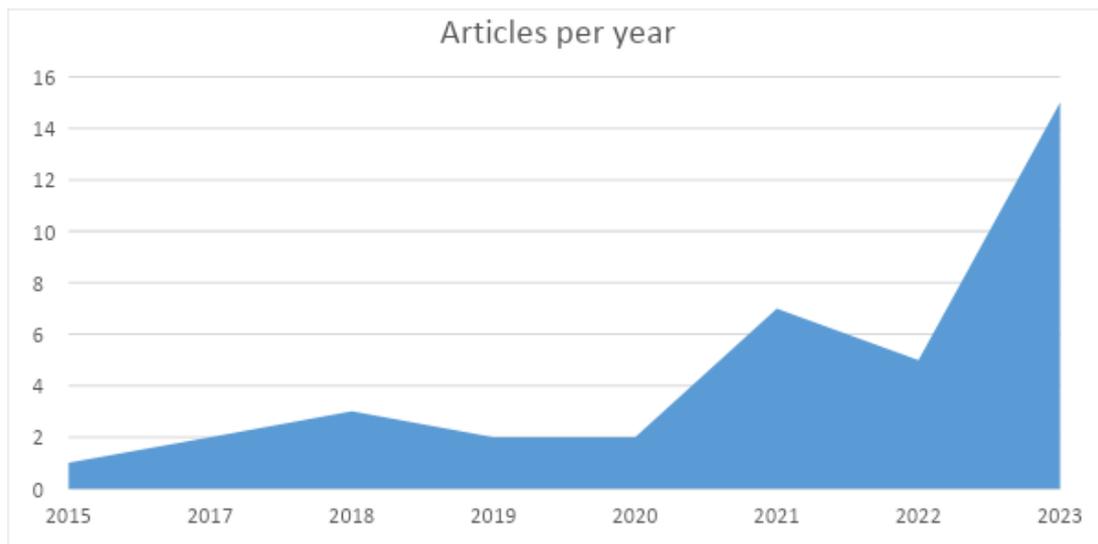


Figure 4: Annual number of publications

3.1.1 Subject area(s)

In terms of the criterion of Subject area(s), we followed two categorization approaches: one using the Academic Journal Guide by the Chartered Association of Business Schools (2021), and one using Scopus built-in classifications. In turn, the two categorization approaches resulted in a total of five categorizations. A summary of these categorizations and their respective data is also presented in Table 2 and expanded upon below.

As per the CABS' Academic Journal Guide, we split the studies examined into seven groups: (A1). Operations and Technology Management with 25/37 articles (68%) , (A2) Operations research & management science with 3/37 articles (8%), (A3) Sector Studies with 3/37 articles (8%), (A4) Social Sciences with 2/37 articles (5%), (A5) General management, ethics & social responsibility with 2/37 articles (5%), (A6) Information Management with 1/37 articles (3%) , (A7) non-rated with 2/37 articles (5%).

A second categorization based on the Academic Journal Guide was done based on the journal ranking. The resulting categories are: (C1) ABS-4, (C2) ABS-3, (C3) ABS-2, (C4) ABS-1 and Non-rated (C5). Most of articles were published in journals that were ranked as ABS-3 (25/37), then ABS-4 (4/37), ABS-2 (3/37), ABS-1 (3/37) and Non-rate (2/37).

As per the Scopus classifications, we first used the "Category" classification, which refers to journal categories, which reflect on broader research categories. Using this classification, the articles can be divided into ten categories. This number illustrates that supply chain resilience is a topic that can be explored through different research lenses. The ten categories are the following: (B1) Strategy and management with 11/37 (30%), (B2) Management Science and Operations Research with 9/37 (24%), (B3) General Business, Management and Accounting with 5/37 (14%), (B4) General Engineering with 3/37 (8%), (B5) Civil and Structural Engineering with 3/37 (8%), (B6) Industrial and Manufacturing Engineering with 2/37 (5%), (B6), Business, management & accounting (miscellaneous) 1/37 (3%) (B8), Finance 1/37 (3%), (B9) Management of Technology and Innovation 1/37 (3%), (B10) Software 1/37 (3%).

Another categorization can be based on the Scopus journal ranking, which results in four categories: (D1) Q1* (top 10) were 30/37 (81%) of the articles, (D2) Q1 (1st quartile, excluding the first 10 percent) 5/37 (14%), (D3) Q2 (2nd quartile) 1/37 (3%), (D4) Q3 (3rd quartile) 1/37 (3%).

Lastly, we used another Scopus-based criterion to categorize studies, and this is the article's "Subject area". In the 37 articles, five categories were identified: (F1) Business, management, and accounting, (F2) Decision sciences, (F3) Engineering, (F4) Computer Science, (F5) Economics, Econometrics and Finance. The results showed that the most popular subject area was Business, management, and accounting (F1) with 18 out of 37. 9 out of 37 were in category Decision sciences, 8 out of 37 were in category Engineering, 1 out of 37 were in category Computer Science & 1 out of 37 Economics Econometrics and Finance.

A. CABS FIELD IN ACADEMIC JOURNAL GUIDE		B. SCOPUS CATEGORY	
A1. Operations and Technology Management - OPS&TECH	25	68%	B1. Strategy and Management
A2. Operations research & management science - OR&MANSCI	3	8%	B2. Management Science and Operations Research
A3. Sector Studies - SECTOR	3	8%	B3. General Business, Management and Accounting
A4. Social Sciences - SOC SCI	2	5%	B4. General Engineering
A5. General management, ethics & social responsibility -ETHICS-CSR-MAN	1	3%	B5. Civil and Structural Engineering
A6. Information Management - INFO MAN	1	3%	B6. Industrial and Manufacturing Engineering
A7. Non-rated	2	5%	B7. Business, management & accounting (miscellaneous)
			B8. Finance
			B9. Management of Technology and Innovation
			B10. Software
TOTAL	37	100%	TOTAL
			37
			100%
C. CABS JOURNAL RANKING		D. SCOPUS JOURNAL RANKING	
C1. ABS-4	4	11%	D1. Q1* (top 10 percent)
C2. ABS-3	25	68%	D2. Q1 (1st quartile, excluded the first 10 percent)
C3. ABS-2	3	8%	D3. Q2 (2nd quartile)
C4. ABS-1	3	8%	D4. Q3 (3rd quartile)
C5. Non-rated	2	5%	
TOTAL	37	100%	TOTAL
			37
			100%
E. NUMBER OF AUTHORS		F. SCOPUS SUBJECT AREA	
E1. One	2	5%	F1. Business, Management and Accounting (BMA)
E2. Two	10	27%	F2. Decision Sciences (DESI)
E3. Three	7	19%	F3. Engineering (ENG)
E4. Four	7	19%	F4. Computer Science (COMP)
E5. Five	2	5%	F5. Economics, Econometrics and Finance (EEF)
TOTAL	37	100%	TOTAL
			37
			100%

Table 2. Results of the first research question

Figure 5 shows the distribution of identified articles by distinct source titles, demonstrating that a diverse range of publications have contributed to the literature in this topic. The 37 studies were published in 17 journals, with the major of them to be in the operations and technology management field. (25/37).

In more detail, six (6) out of 37 (16%) of the articles were published in the “International Journal of Operations and Production Management.” It is a peer-reviewed academic journal that is published every month and covers various topics regarding supply chain management and operations management. Moreover, four 4 out of 37 (11%) articles were published in the “Journal of Supply Chain Management”. It is a peer-reviewed academic journal that is published every 3 months, covering topic from marketing, strategic management to operations management, supply chain management, and social network analysis. Four (4) out of 37 articles (11%) were published in the “Journal of International Economics”. This is peer-reviewed academic journal, that publishes articles on both theoretical and empirical aspects of global economics. Four (4) articles out of 37 (11%) were published in the “International Journal of Operations and Production Management”. This journal is a month peer-reviewed academic journal that is published on a monthly basis and covers all aspects of supply chain management and operations management.

Other journals that published articles are the following, Annals of Operations Research (3/37), Transportation Research Part E: Logistics and Transportation Review (3/37), Business Strategy and the Environment (2/37), Business Strategy and the Environment (2/37), Computers and Industrial Engineering (2/37), Applied Soft Computing (1/37), Expert Systems with Applications (1/37), Applied Soft Computing (1/37), Expert Systems with Applications (1/37), IEEE Transactions on Engineering Management (1/37), International Journal of Physical Distribution and 1/37), Logistics Management 1/37), Journal of Business Logistics 1/37), Journal of Business Research 1/37), Operations Management Research 1/37), Sustainable Production and Consumption 1/37), TQM Journal 1/37)

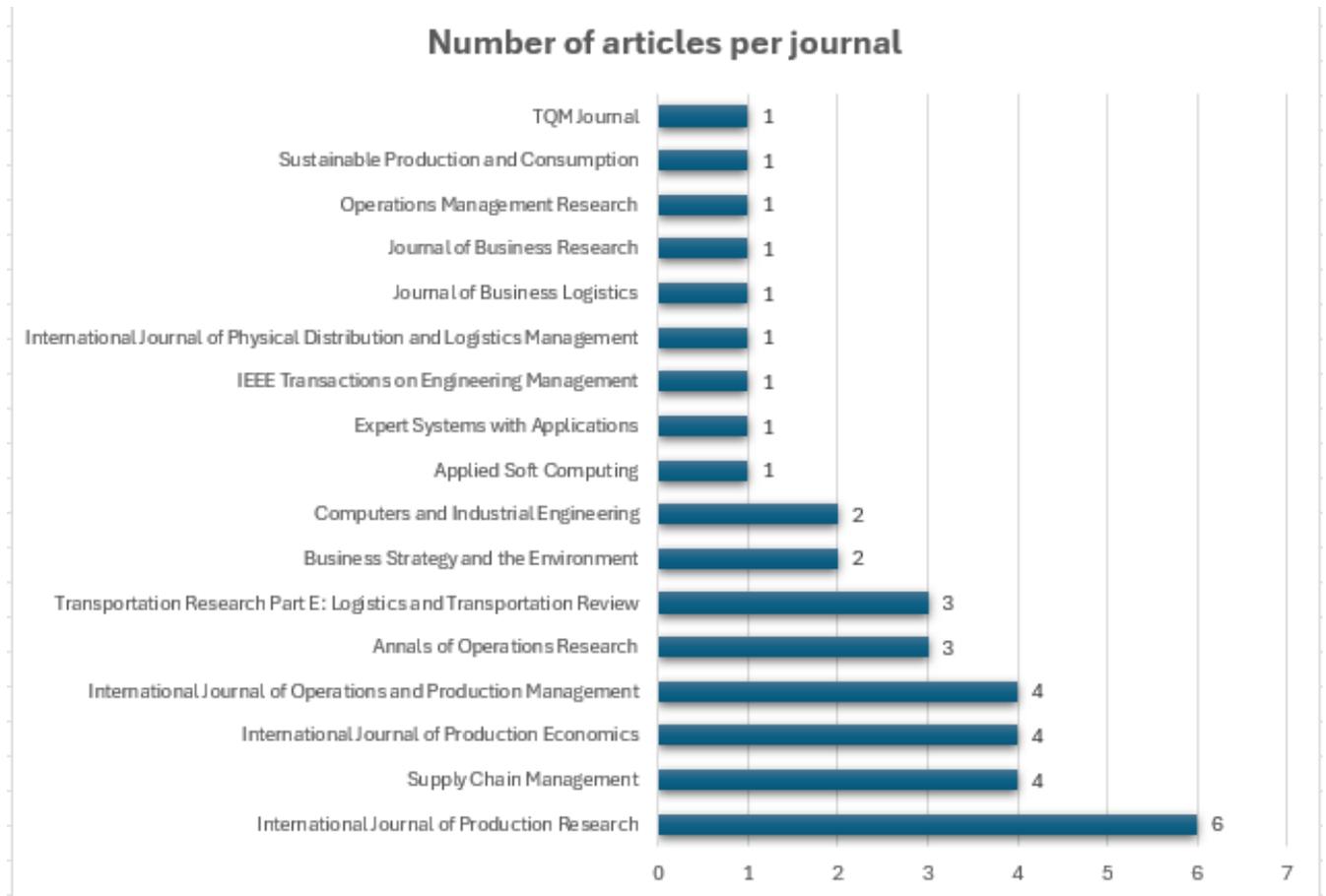


Figure 5. Articles per journal

3.1.2 Geographic area(s)

This criterion is adopted to see the countries in which the studies are conducted. As it is depicted in Table 3, articles are published in 10 different countries in the European union. The countries are the following: France (10 articles - 27%), Germany (9 articles - 24%), Italy (5 articles - 14%), Finland (3 articles - 8%), Netherlands (3 articles - 8%), Spain (2 articles - 5%), Denmark (2 articles - 5%), Ireland (1 article - 3%), Portugal (1 article - 3%) and Austria (1

article - 3%). Based on the MSCI classification⁷ all the above countries are considered developed countries.

Number of articles per country		
France	10	27%
Germany	9	24%
Italy	5	14%
Finland	3	8%
Netherlands	3	8%
Spain	2	5%
Denmark	2	5%
Ireland	1	3%
Portugal	1	3%
Austria	1	3%
Total	37	

Table 3. Number of articles per country

3.1.3 Number of authors

We also performed an analysis of the articles based on the number of authors per article. We conclude in five cases: one (E1), two (E2), three (E3), four (E4) and five (E5).

Most of the articles were written by two authors. (10 out of 37). Moreover, it is noteworthy that only 2 out 37 articles were written by one author, meaning that this topic encourages co-authoring.

In regard to quantity, the author that wrote the most articles was Ivanov D. (5 articles). Additionally, there were 17 authors that wrote more than 2 articles. Table 4 indicates the number of articles per author.

Author	Number of articles
Ivanov D.	5
Dolgui A.	4
Sokolov B.	3

⁷ <https://www.msci.com/our-solutions/indexes/market-classification>
Postgraduate Dissertation

Birkel H.	3
Spieske A.	3
Hallikas J.	2
Immonen M.	2
Lintukangas K.	2
Hosseini S.	2
Mohammed A.	2
Silva M.E.	2
Scholten K.	2
Wieland A.	2
El Baz J.	2
Ruel S.	2
Gebhardt M.	2
Kopyto M.	2

Table 4. Articles per author

We also categorized the articles based on the countries/universities of origin, but also whether co-authors originate from the same or different countries. As presented in Table 5, the majority of the articles were for multiple countries (25 out of 37). As a result, supply chain resilience is a topic that favors collaborations and concerns authors all around the globe.

Number of Countries		
Multi country	25	68%
Single country	12	32%
Total	37	

Table 5. Number of countries of origin per article

3.2 RQ2: What are the key points & contents of the literature in supply chain resilience

3.2.1. Methodologies used

We conducted a deep dive analysis to understand the motivation of the authors and the specific methodologies that those led to, in the selected bibliography. After examining all 37 papers, it appears that a primary motivation for the authors was to address a gap in the existing literature (23 out of 37 articles, amounting to 62% of the total). Additionally, the COVID-19 pandemic served as another significant driver, influencing 14 out of the 37 articles (38% respectively).

Addressing the primary motivations described above, the methodological approaches employed in the selected papers could be classified using the classification framework introduced by Chowdhury et al. (2021). This framework has proposed five (5) methodological categories:

1. Empirical: we check if for the writing of the studies one of the following methods is used: (i) case studies, (ii) interviews, (iii) focus groups, (iv) surveys and/or (v) Delphi techniques.
2. Quantitative: we check if in the articles mathematical models or analytical modeling or simulation models and/or the Multi-Criteria Decision Making (MCDM) methods are used.
3. Literature reviews: we check if the studies are (i) systematic reviews, (ii) literature reviews, (iii) structured literature, (iv) critical review, (v) conceptual review, (vi) bibliometric review, (vii) analytical review, (viii) integrative review, and (ix) extensive review.
4. Researchers' opinions: we check if the studies are (i) viewpoints, (ii) discussion papers, (iii) opinion pieces and (iv) commentaries.
5. Mixed methodologies: if for this paper two methods are used empirical methods (as analyzed in category 1) and also quantitative methods (as analyzed in category 2).

After studying the content of the 37 articles, we found that there is a direct correlation between our selected corpus and the categories listed above. This conviction has been strengthened by examining the “Indexed keywords” field obtained from Scopus, which often explicitly states the methodological category of each article. Figure 6 below illustrates the distribution of the methodological categories of the examined papers, along with the number and percentage of articles from each category.

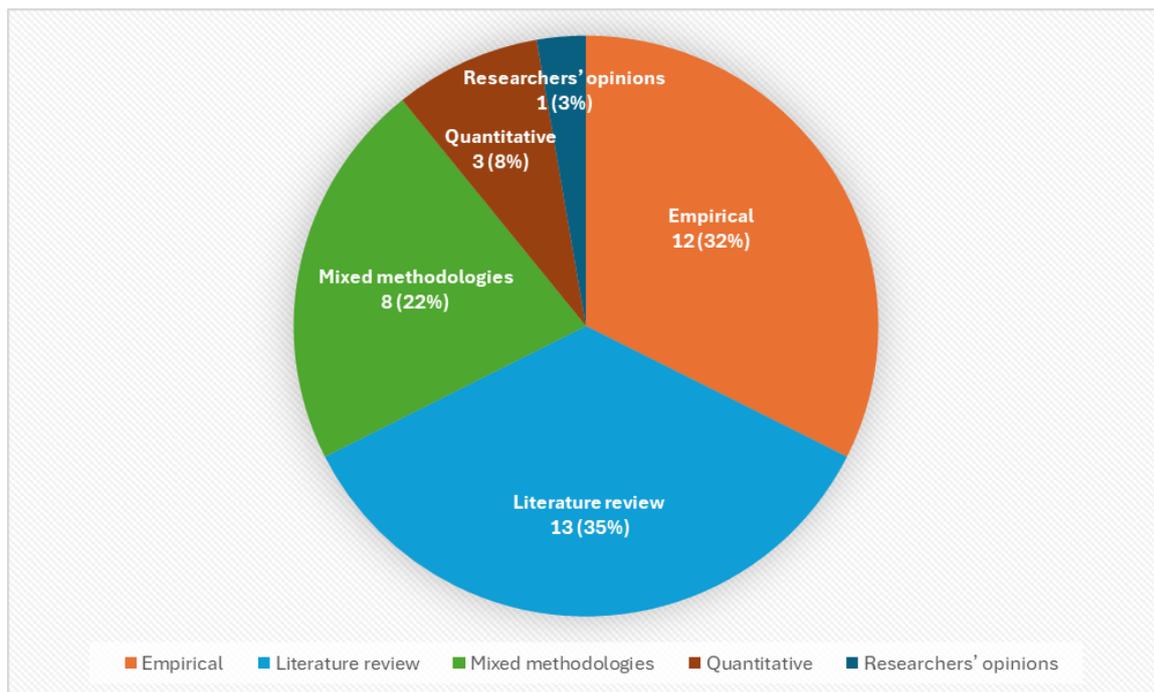


Figure 6. Methodological categories used in reviewed articles.

It is clear that the main bulk of papers analyzed employ literature review methodologies (35%). At second place we find empirical with (32%), followed by mixed methodologies (22%) and lastly, quantitative methodologies (8%). Also, we found 1 opinion paper while conducting our SLR.

Below, we subdivide the papers even further in terms of specific research methods used. In most cases, these specific methods can also be cross-referenced by the metadata fields of each publication obtained from Scopus, specifically in the “Indexed Keywords” section.

Methodological category	Specific Methods	Number of articles	References
Empirical	Case study	7	Scholten et al. (2015), Scholten et al. (2019), Baz et al. (2021), Herold et al. (2021), Cherrafi et al. (2022), Betto et al. (2023), Carissimi (2023)
	Survey	5	Brusset et al. (2017), Zouari et al. (2021), Gebhardt et al. (2022), Dubey et al. (2023), Harju et al. (2023)
Quantitative	Mathematical model	1	Pavlov et al. (2018)
	Analytical model	0	
	Simulation	2	Ivanov (2018), Burgos et al. (2021)
	Secondary data analysis	0	
	MCDM method	0	
Literature review	Literature review	8	Ivanov et al. (2017), Dolgui et al. (2018), Hosseini et al. (2019), Hosseini et al. (2020), Piya et al. (2022), Pimenta et al. (2022), Wieland et al. (2023)
	Systematic/Structured literature review	4	Spieske et al. (2021), Negri et al. (2021), Zamani et al (2023), Castillo (2023)
	Analytic review	1	Wieland et al. (2021)
Researchers' opinions	Position paper	1	Ivanov et al (2020)
Mixed methodologies		8	Sauer et al. (2022), Ribeiro et al (2023), Laguir I. et al (2023), Cotta et al (2023), Kähkönen et al. (2023), Spieske et al. (2023), Mohammed et al (2023), Silva et al. (2023)

Table 6. Specific research methods used in reviewed articles

3.2.2 Theories

In the literature, considerable attention is directed towards theoretical frameworks and strategies intended to address the issues raised by the pandemic. Accordingly, to the article written by Ribeiro (2022), when following pro-active resilient strategies, positive effects on supply chain (SC) performance can be reported. Some examples are ripple effect reduction, responsiveness enhancement, and service quality improvement. The article emphasizes the importance of decision-makers refraining from adopting universal strategies for SC management, instead advocating for the formulation of customized plans tailored to the specific operations of their supply chains.

Another theory analyzed by Ivanov, Hosseini, & Dolgui (2019) is the concept of resilience capacity. This is an important aspect of system performance under uncertainty, and it contains resilience enhancement elements that can improve a system's ability to absorb, adapt, and repair itself following interruption. This approach is organized around "three lines of defense," with each representing temporal features before, during, and after a disturbance. The three (3) lines are: absorptive capacity, adaptive capacity, and restorative capacity.

Absorptive capacity is defined as a system's ability to absorb or withstand the impact of system disruptions while limiting the negative repercussions to low amounts of energy or effort. The resilience mechanisms at this level are as follows: a) Multiple sourcing, b) Inventory risk mitigation, and c) Supplier segmentation. Multiple sourcing strategies can allow decision makers to achieve a better service level and lower the risks compared to single sourcing. Risk mitigation inventory consists of strategies regarding ordering as well as stocking decisions. Supplier segmentation includes the geographic separation of the supplier, and this can reduce the disruption risks in cases of a regional disaster that can affect the manufacturing facility.

The definition of the adaptive capacity is the ability that a system has to adjust and counter disruptions through the adoption of nonstandard operation practices without depending on recovery operations. It is characterized also as the second level of defense against disruption and some resilient mechanisms are the following: backup supplier plan, rerouting, communication, and substitution. Supply chain resilience enhancement can be achieved by having a backup supplier. Also rerouting even using nonstandard or more expensive routing options is crucial for operations continuity. Appropriate communication and collaboration

among the members of the SC can also help overcome disruptions. Substitution is characterized as the temporary ability of manufacturers to substitute raw materials until the disturbance is over.

Restorative capacity is defined as the system's ability to restore quickly and efficiently when absorptive and adaptive capacities are insufficient to maintain acceptable performance. It is described as the last line of protection when the system is compromised and unable to function. Mechanisms for resilience are recommended, such as defined restoration budgets and technical resource restoration, to allow suppliers to quickly recover from disruptions.

Ivanov *et al.* (2019) provide a definition for SCR, highlighting the three key categories of resilience capacity, emphasizing the importance of absorptive capacity, when insufficiencies are observed in its other types. In addition, SCR is presented as a hierarchical structure, as depicted in Figure 7, and explained below (in bottom-up order):

1. Resilience enhancement/bottom level: features that enhance resilience, such as surplus inventory or backup supplier.
2. Resilience capacity, which includes a) absorptive, b) adaptive, and c) restorative capacities.
3. SCs with enhanced resilience capacity require less recovery efforts when they are subject to disruptions. Conversely, supply chains that are not as capable of resilience face higher vulnerability and necessitate extensive efforts to recover.
4. The top level of the hierarchy (SCR) corresponds to how vulnerable and recoverable the SC is in case of disruptions.



Figure 7. Supply chain resilience hierarchy

Ivanov and Dolgui (2020), in another publication they introduced the term “Intertwined Supply Network” (ISN). ISN refers to a comprehensive network of interconnected supply chains that can ensure the delivery of products and services to the markets and society. ISNs are open systems as companies are able to change buyer-supplier roles in interconnected SCs. From the aspect of resilience, the ISNs are crucial in ensuring long term survival (as they provide food service-communication). The authors also explain how disturbances at one node in the supply network can cascade across the system, causing major disruptions and risk amplification. This is explained by the fact that supply chains seldom exist as isolated entities; but they function as open systems marked by structural dynamics. Over time, supply chains evolve into ISNs, demonstrating inherent structural dynamics.

Mohammed, Lopes de Sousa Jabbourb and Diabat (2021) argue strongly that in order to develop a resilient supply chain both internal and external resilience must be combined. This study adds to the subject of supply chain resilience by proposing an integrated methodology meant to analyze supply chain resilience regarding an enterprise's internal dynamic capacities and the resilience of its suppliers. This methodology is applicable to managers, such as purchasing managers, production managers, and engineering managers, providing a valuable tool for measuring and analyzing weaknesses in their businesses. Consequently, it facilitates directing efforts towards enhancing overall supply chain resilience.

Last but not least, another publication by Harju et al. (2023) discusses the effect of digitalization of procurement processes on supply chain resilience, featuring empirical data from Finland. It presents that information sharing and appropriate management can be positive drivers towards enabling supply chain resilience. According to the same study, companies that employ data analytics systematically, can expand their information-processing capacity, that can potentially reduce uncertainty in the SC. Moreover, many data sources can be leveraged in the context of SC risk analytics to improve the SC's proactive and resilient behavior.

3.3 RQ3: What are the opportunities for future research?

The third research question aims to give more insights for possible future research avenues. To answer this question, we used a two-stage method. First, we examine RQ1 and RQ2 to give recommendations for future research. Second, we deep dive into the most cited papers & the paper with the higher CPY score to generate new research ideas.

3.3.1 Recommendations based on RQ1 and RQ2 assessment

Supply chain resilience as a term has been explored extensively in the literature, but still there are many opportunities for future research. First, the countries referred to in analyzed research papers feature developed markets, based on the MSCI classification. Subsequently, it would be really interesting to investigate articles in less developed markets: emerging, or even frontier markets according to the MSCI classification. These could be markets within developing countries of the EU or other economic regions globally.

In regard to authors, we have noticed that 17 authors wrote more than 1 paper meaning that the authors are specialized in the specific topic of SCR. It would be ideal if more authors got involved in SCR topics in order to help the research evolve. Collaboration between authors in the field could provide opportunities for more empirical research papers, such as case studies in different contexts. The introduction of new research authors could help introduce new research methods and also possibly bring expertise from other fields, such as engineering, ecology and information technology.

In terms of the methodology most of the papers employed literature review (35%) and empirical (32%) methodologies. It is obvious that there is a lack in literature in terms of

quantitative methodologies (8%). Moreover, the topic of SCR can be analyzed more extensively with the use of mathematical models, analytical models, simulations, secondary data analysis and multiple-criteria decision-making (MCDM) methods.

Another major issue concerns the measurement and assessment of supply chain resilience. While several frameworks and approaches have been offered for assessing resilience, there is still a lack of agreement on the most relevant metrics and indicators. Many present techniques rely on quantitative indicators like recovery time and cost, but there is a need for more holistic and comprehensive metrics that highlight the multifaceted character of resilience.

3.3.2 Recommendations using the most cited articles

We focused on the 10 most cited studies, based on Scopus, in order to identify areas that have not been yet investigated. As verified also in Table 7, there are areas that have not been yet explored, providing grounds for potential future research.

Based on the article written by Ivanov & Dolgui (2020), the intertwined supply network methodology needs to be investigated further. Some potential topics for investigation are definition of ISN viability and SC survivability concepts, ISN network structures and viability, roles and dynamics of ISNs during pandemic outbreaks. Also, the ripple effect in ISNs and the game-theoretic modelling of ISN viability.

Another promising avenue for future research is the application of optimization of Bayesian networks (BN), stochastic programming modeling (two-stage), and Markov chains for addressing SCR problem (Hosseini & Ivanov, 2020). BN can be an effective tool for risk analysis, decision support & uncertainty handling. A distinctive aspect of BNs is their inference analysis, enabling the simulation of the ripple effect, or the propagation impact of a disruptive event on supply chain entities. While BNs have found extensive use in modeling and measuring resilience in various systems, including waterway transportation, urban infrastructure, manufacturing, and energy, their application to SC resilience is relatively new and requires further exploration. Markov chain modeling can be used to forecast a supply chain element's resilience and recoverability. For example, it can be applied on supplies, manufacturing facilities or ports.

Moreover, regarding SCR in Industry 4.0 (Hosseini & Ivanov, 2020), the use of digital technology as well as empirical validation of the relationship between the intersections of I4.0 and SCR (Spieske & Birkel, 2021), is another recommendation for future research. While Industry 4.0 has attracted a lot of interest in recent years, there has been insufficient focus on developing resilient digital technologies specifically for it. Few studies have evaluated how digital technology and Industry 4.0 will affect SC hazards. Industry 4.0-driven SCs exhibit significant potential, due to the adoption and use of robotics, cognitive technologies, additive manufacturing, advanced materials and high-performance computing. Simultaneously, digital technologies offer novel avenues for mitigating disruption risks (Ivanov, Hosseini, & Dolgui, 2019).

Scholten and Schilder (2015) emphasize the significance of identifying redundant resources as a vital component of improving supply chain resilience. While efficiency is crucial in supply chain management, it is also critical to strike a balance by investing in redundant resources. These redundant resources act as disruption buffers, allowing businesses to endure unexpected events while maintaining operational continuity. Main goal of the businesses is to maintain the balance between redundancy and efficiency, in order to achieve better cost control and remain competitive. As a result, finding the balance between redundancy and efficiency is critical for properly managing supply chain resilience in the unstable business environment.

Based on (Dolgui, Ivanov, & Sokolov, 2017), another research avenue for the future is the analysis of ripple effect and how it affects the supply chain resilience. By analyzing the ripple effect and visualizing how it is spread through the supply chain, researchers will be able to develop strategies to mitigate the negative effects and the disruptions it can cause. Moreover, an analysis into the closed-loop supply chains, and specifically in material reuse and recycling, can have a great impact in supply chain sustainability and resilience. Another field for research for the future based on the article of Ivanov & Dolgui 2020, is the low-certainty-need (LCN) SCs. The LCN framework presents a novel technique in managing risks and help organizations to enhance resilience and agility. The LCN method focuses on flexibility and responsiveness, enabling supply chains to react to possible disruptions. Nowadays market conditions and customer preferences are unpredictable, so traditional supply chain management strategies may not be effective, so LCN is a useful alternative. Additionally,

another topic for further research is the role of digital technology in developing an LCN framework.

Author	Future research	Citations
Ivanov, Dolgui (2020)	The intertwined supply network methodology needs to be investigated, the role of ISN survivability and viability and trophic chain modeling can be examined in depth.	914
Hosseini, Ivanov, Dolgui (2019)	Future research can be divided into two main streams: Methodology-based studies, particularly focusing on the applications of optimization of Bayesian networks (BN), stochastic programming modeling (two-stage), and Markov chains.	618
Scholten, Schilder, (2015)	Explore redundant resources that are required for supply chain resilience & also explore the balance of those redundancies with efficiency. Include underlying risks by using Kraljic's matrix	483
Dolgui, Ivanov, Sokolov (2018)	Future research ideas are the following: ripple effect visualization, how human factors affect the ripple effect as well as closed loop SCs. The role of SC digitalization, how to combine empirical research and simulation;	469
Ivanov, Dolgui. Sokolov, Ivanova (2017)	Quantitative analysis in empirical identified areas of SC risk management. Integrating operability objects (KPIs: resilience, stability robustness)	412
El Baz, Ruel (2021)	Future studies in other countries highlight similarities and/or differences with other contexts. Also having data for a longer period of time might give other results. How SC resilience and robustness might influence firms' performances	371
Brusset, Teller (2017)	Apply the survey in more countries & use experts from other part of the company. Include more moderator except from risk such as firm or supply chain characteristics in order to identify capability-resilience	318

	relationships. The role of managerial expertise in information technology	
Wieland, Durach (2021)	How supply chain resilience is linked to the wider resilience debates in other fields	179
Spieske, Birkel (2021)	Empirical validation of the association between the intersections of supply chain resilience and I4.0 industry.	173

Table 7. Indicative impact of the most cited articles

In addition to the above, Table 8 presents the top-ten research publications with regards to citations per year (CPY). The results indicate that there are publications that were momentarily considered by the research community in a specific period of time, but not cited consistently ever since. Therefore, this metric could hint to interesting research topics and findings, which could be revisited in the future if similar disruption events, like the pandemic happen again.

For example, in the research publications, there are examples of research that points to actual supply chain resilience practices that could be employed during large-scale disruption events. Researchers can discover best practices and lessons learned from previous disruptions by analyzing real-world case studies and empirical data, which can then be used to design successful resilience strategies for future crises. (Negri, Cagno, Colicchia, & Sarkis, 2021). Other publications offer a window to the past through case studies that refer to specific countries and/or areas (Kähkönen, Evangelista, Hallikas, Immonen, & Lintukangas, 2021). Such publications offer a historical account of how the pandemic has disrupted SCs in different geographic and economic contexts, which could be a very valuable resource for future reference, in case of a similar pandemic occurs again. Also the next stage of research might be the examination of behaviors connected to major competencies on a sub-level. Researchers can boost resilience by developing new capabilities with improved technologies.

Moreover, another major issue that is highlighted is the measurement and assessment of supply chain resilience. While several frameworks and approaches have been offered for assessing resilience, there is still a lack of agreement on the most relevant metrics and indicators. Many present techniques rely on quantitative indicators like recovery time and cost, which may not

fully capture the multidimensional nature of resilience. As a result, there is a need for more holistic and comprehensive metrics that can highlight the multifaceted character of resilience, taking into consideration factors such as adaptability, agility, and robustness across various dimensions of the supply chain network. Addressing this issue is critical for properly analyzing and improving supply chain resilience in today's volatile and uncertain business environment.

Author	Future research	CPY
Ivanov, Dolgui (2020)	The intertwined supply network methodology needs to be investigated, the role of ISN survivability and viability and trophic chain modeling can be examined in depth.	229
El Baz, Ruel (2021)	Future studies in other countries highlight similarities and/or differences with other contexts. Also having data for a longer period of time might give other results. How SC resilience and robustness might influence firms' performances	124
Hosseini, Ivanov, Dolgui (2019)	Future research can be divided into two main streams: Methodology-based studies, particularly focusing on the applications of optimization of Bayesian networks (BN), stochastic programming modeling (two-stage), and Markov chains.	124
Dolgui, Ivanov, Sokolov (2018)	Future research ideas are the following: ripple effect visualization, how human factors affect the ripple effect as well as closed loop SCs. The role of SC digitalization, how to combine empirical research and simulation;	78
Burgos, Ivanov (2021)	How SC policies can help in controlling the ripple effect in case of pandemic outbreaks. How digital technologies can help recover from the pandemic. How robotics and automations can be implemented in distribution centers	60
Wieland, Durach (2021)	How supply chain resilience is linked to the wider resilience debates in other fields	60

Ivanov, Dolgui, Sokolov, Ivanova (2017)	Quantitative analysis in empirical identified areas of SC risk management. Integrating operability objects (KPIs: resilience, stability robustness)	59
Spieske, Birkel (2021)	Empirical validation of the association between the intersections of supply chain resilience and I4.0 industry.	58
Scholten, Schilder (2015)	Explore redundant resources that are required for supply chain resilience & explore also the balance of those redundancies with efficiency. Include underlying risks by using Krajic's matrix	54
Kähkönen, Hallikas, Immonen, Lintukangas (2023)	Examine strategies that companies can adopt in case of supply chain disruptions. Conduct comparative analysis on the impact of pandemic in different sectors and countries.	46
Negri, Cagno, Colicchia Sarkis (2021)	Conduct empirical investigations into implemented SCR practices –by companies- and their effect. Human and organizational behavior factors in order to adapt SCR practices.	46

Table 8. Top-ten cited studies based on CPY (citations per year)

4. Conclusion

4.1. Closing remarks

Supply chain resilience has become increasingly important in today's dynamic and uncertain business environment, which is marked by frequent disruptions and uncertainties. It refers to a supply chain's ability to foresee, tolerate, recover from, and adapt to various disturbances while maintaining core functions and performance. Academics and policymakers have paid close attention to the notion, as natural disasters, geopolitical conflicts, economic crises, and pandemics like the COVID-19 epidemic continue to pose substantial problems to global supply chains. The COVID-19 pandemic exposed the vulnerability of non-resilient global supply networks, causing many organizations to experience business interruptions due to supply delays or stoppages. Furthermore, many firms were impacted by the absence of a survival resilience plan inside their SC risk management. Over recent years, SC literature has intensified emphasis on understanding how supply chains have responded to one of the biggest and most unforeseen events that has ever occurred (Castillo, 2023).

As demonstrated in Sections 2 and 3, the significant amount of research publications on this topic recently proves the increasing interest in SCR. Based on literature findings, resilience is one of the integral components of SCs. Academic articles on the field propose diverse definitions for it and offer various models that elucidate the action framework (Castillo, 2023).

The analyzed publications reveal that numerous research theories have started to appear in the topic of SCR. Research indicated that pro-active resilience strategies can have a positive impact on supply chain performance. Meanwhile, the concept of resilience capacity has been introduced, expanded through three concepts/lines of defense. Moreover, focus was placed on the main drivers of SCR and how those can contribute in maximizing resilience. Last but not least, the concept of SCR hierarchy was explored, which discusses the different layers that should be addressed to build resilient supply chains.

The future of supply chain resilience is also analyzed in this dissertation. Usage of digital technology can ensure firm resilience in a rapidly changing and turbulent environment. Blockchain technology (BC) can give complete solutions to SC problems such as disruptions, shortages, poor quality, cross-delivery. BC is viewed as an opportunity that enhances resilience

Postgraduate Dissertation

within the system. Furthermore, the discussion has delved into Bayesian networks and their integration with machine learning algorithms to address significant big data supply chain problems. BNs seem to be an effective tool for resolving SC risk and resilience issues, with the capacity to imitate the effects of unanticipated interruptions on supply chain resilience using FP analysis. One another note the significance of information sharing and collaboration in improving supply chain resilience is still understudied. While there is widespread agreement on the value of collaboration among supply chain participants, empirical evidence on the mechanisms by which information sharing leads to resilience is limited. Furthermore, the use of digital technologies such as blockchain, Internet of Things (IoT), and artificial intelligence (AI) to improve supply chain resilience offers a promising route for research, but it is still in its early stages.

4.2 Limitations

The SLR process is different from the conventional ones as it includes subjectivity, as the outcomes are dependent on the inclusion criteria used by the researcher. There is still a possibility of some missing studies, even though we are under the impression that all appropriate contributions have been included. We are confident that new publications will not have an impact on the unambiguous findings of this SLR.

At the time of authoring this dissertation (end of 2023), research publications of a very specific temporal period have been examined. It is possible that more interesting research outcomes will surface, since markets are still affected by the turbulent global events in the post-pandemic era. Additionally, our analysis has been performed by using certain geographical limitations (EU countries), so future research can be done in other geographical contexts, in order to identify if there are any similarities and emerging patterns.

In terms of research criteria used, we specifically included articles from highly-ranked journals in the English language. Thus, a) books, conference papers, and unpublished works were not included in this research and b) information pieces in different languages were not considered, although they could provide significant contributions to the research topic at hand. Last but not least, our choice of database (Scopus) may have limited our access to research publications.

Other online repositories could be considered in the future, such as Google Scholar, Web of Science or ResearchGate.

4.3 Directions for future research

Future research publications may attempt to eliminate the gap between resilience and sustainability issues by deploying stochastic models, which will explore the balance of sustainable and resilience decisions. While numerous researchers have applied multi-criteria decision-making (MCDM) methods to solve problems related to resilient supplier selection, other MCDM methods, such as (i) the technique for order of preference by similarity to ideal solution (TOPSIS), (ii) analytical hierarch process (AHP), have not been thoroughly investigated within the context of supply chain resilience. A proposed focus is on the applications of MCDM methods to address challenges related to resilient suppliers and vendors.

Multi-criteria decision-making (MCDM) can be used to evaluate supply chain networks in regard to resilience, environmental sustainability, as well as organizational criteria. Expansion in theoretical concepts and frameworks is also possible and – to a large extent – expected. As numerous case studies from a variety of socio-economic contexts emerge, new challenges will be offered to future researchers to explore and solve. For example, there is a gap in literature in the quantitative analysis of internal resilience capabilities (IRCs), focusing on the internal capacity of organizations to build resilient supply chains. In this and similar research areas, development of theories and strategies by combining insights from other research sectors (e.g. information technology) would be undoubtedly interesting for the field.

References

- Ahmad, M. O., Dennehy, D., Conboy, K., & Oivo, M. (2018). Kanban in software engineering: A systematic mapping study. *Journal of Systems and Software*, *137*, 96–113. doi:10.1016/j.jss.2017.11.045
- Baz, J. E., & Ruel, S. (2021). Can supply chain risk management practices mitigate the disruption impacts on supply chains' resilience and robustness? Evidence from an empirical survey in a COVID-19 outbreak era. *International Journal of Production Economics*, *233*, 107972. doi:https://doi.org/10.1016/j.ijpe.2020.107972
- Betto, F., & Garengo, P. (2023). A circular pathway for developing resilience in healthcare during pandemics. *International Journal of Production Economics*, *266*, 109036. doi:https://doi.org/10.1016/j.ijpe.2023.109036
- Brusset, X., & Teller, C. (2017). Supply chain capabilities, risks, and resilience. *International Journal of Production Economics*, *184*, 59-68. doi:https://doi.org/10.1016/j.ijpe.2016.09.008
- Burgos, D., & Ivanov, D. (2021). Food retail supply chain resilience and the COVID-19 pandemic: A digital twin-based impact analysis and improvement directions. *Transportation Research Part E: Logistics and Transportation Review*, *152*, 102412. doi:https://doi.org/10.1016/j.tre.2021.102412
- Butt, A. (2021, August). Supply chains and COVID-19: impacts, countermeasures and post-COVID-19 era. *The International Journal of Logistics Management*. doi:10.1108/IJLM-02-2021-0114
- Carissimi, M. C., PrataViera, L., Creazza, A., Melacini, M., & Dallari, F. (2022, June). Blurred lines: the timeline of supply chain resilience strategies in the grocery industry in the time of Covid-19. *Operations Management Research*, *16*, 1-19. doi:10.1007/s12063-022-00278-4
- Castillo, C. (2023, January). Is there a theory of supply chain resilience? A bibliometric analysis of the literature. *43*, 22-47. doi:10.1108/IJOPM-02-2022-0136

- Choi, T., Narayanan, S., Novak, D., Olhager, J., Sheu, J.-B., & Wiengarten, F. (2021, April). Managing extended supply chains. *Journal of Business Logistics*, 42. doi:10.1111/jbl.12276
- Chowdhury, P., Paul, S., Kaiser, S., & Moktadir, M. (2021, April). COVID-19 pandemic related supply chain studies: A systematic review. *Transportation Research Part E Logistics and Transportation Review*, 148, 102271. doi:10.1016/j.tre.2021.102271
- Christopher, M., & Peck, H. (2004, January 01). Building the Resilient Supply Chain. *The International Journal of Logistics Management*, 15, 1–14. doi:10.1108/09574090410700275
- Concetta Carissimi, M., Prativiera, L., Creazza, A., Melacini, M., & Dallari, F. (2022). *Blurred lines: the timeline of supply chain resilience strategies in the grocery industry in the time of COVID-19*. *Oper Manag Res*. doi:10.1007/s12063-022-00278-4
- Cotta, D., Klink, L., Alten, T., & Madhoo, B. (2022, December). How do supply chain managers perceive the relationship between resilience and sustainability practices? An exploratory study. *Business Strategy and the Environment*. doi:10.1002/bse.3325
- Dolgui, A., Ivanov, D., & Sokolov, B. (2017, October). Ripple effect in the supply chain: an analysis and recent literature. *International Journal of Production Research*, 56, 1-17. doi:10.1080/00207543.2017.1387680
- Dubey, R., Graham, G., Bryde, D., Dwivedi, Y., & Foropon, C. (2023, January). Dynamic Digital Capabilities and Supply Chain Resilience: The role of Government Effectiveness. *International Journal of Production Economics*, 258. doi:10.1016/j.ijpe.2023.108790
- Gebhardt, M., Spieske, A., Kopyto, M., & Birkel, H. (2022, June). Increasing global supply chains' resilience after the COVID-19 pandemic: Empirical results from a Delphi study. *Journal of Business Research*, 150. doi:10.1016/j.jbusres.2022.06.008
- Gokhale, A. (1998). *Enterprise-wide networking for manufacturing* (Vol. 35). Computers and Industrial Engineering. doi:10.1016/S0360-8352(98)00045-X
- Gokhale, A. A. (1998, October). Enterprise-wide networking for manufacturing. *Computers & Industrial Engineering*, 35, 259-262. doi:10.1016/S0360-8352(98)00045-X

- Harju, A., Hallikas, J., Immonen, M., & Lintukangas, K. (2023, January 01). The impact of procurement digitalization on supply chain resilience: empirical evidence from Finland. *Supply Chain Management: An International Journal*, 28, 62-76. doi:10.1108/SCM-08-2022-0312
- Herold, D., Nowicka, K., Pluta-Zaremba, A., & Kummer, S. (2021, June). COVID-19 and the pursuit of supply chain resilience: reactions and “lessons learned” from logistics service providers (LSPs). *Supply Chain Management: An International Journal*, ahead-of-print. doi:10.1108/SCM-09-2020-0439
- Hoek, R. (2020, June). Research opportunities for a more resilient post-COVID-19 supply chain – closing the gap between research findings and industry practice. *International Journal of Operations & Production Management*, ahead-of-print. doi:10.1108/IJOPM-03-2020-0165
- Hohenstein, N.-O., Feisel, E., & Hartmann, E. (2014, April). Human resource management issues in supply chain management research: A systematic literature review from 1998 to 2014. *International Journal of Physical Distribution & Logistics Management*, 44, 38-52. doi:10.1108/IJPDLM-06-2013-0175
- Hosseini, S., & Ivanov, D. (2020, June). Bayesian Networks for Supply Chain Risk, Resilience and Ripple Effect Analysis: A Literature Review. *Expert Systems with Applications*, 113649. doi:10.1016/j.eswa.2020.113649
- Ivanov, D. (2020, May). Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*, 319, 1-21. doi:10.1007/s10479-020-03640-6
- Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, 58, 2904-2915. doi:10.1080/00207543.2020.1750727

- Ivanov, D., Dolgui, A., Sokolov, B., & Ivanova, M. (2017, June). Literature Review on Disruption Recovery in the Supply Chain. *International Journal of Production Research*, 1-17. doi:10.1080/00207543.2017.1330572
- Ivanov, D., Hosseini, S., & Dolgui, A. (2019, March). Review of quantitative methods for supply chain resilience analysis. *Transportation Research Part E Logistics and Transportation Review*, 125, 285-307. doi:10.1016/j.tre.2019.03.001
- Kähkönen, A.-K., Evangelista, P., Hallikas, J., Immonen, M., & Lintukangas, K. (2021, December). COVID-19 as a trigger for dynamic capability development and supply chain resilience improvement. *61*, 2696-2715. doi:10.1080/00207543.2021.2009588
- Kamalahmadi, M., & Parast, M. (2015, November). A Review of the Literature on the Principles of Enterprise and Supply Chain Resilience: Major Findings and Directions for Future Research. *International Journal of Production Economics*, 171. doi:10.1016/j.ijpe.2015.10.023
- Laguir, I., Modgil, S., Bose, I., Gupta, S., & Stekelorum, R. (2022, January). Performance effects of analytics capability, disruption orientation, and resilience in the supply chain under environmental uncertainty. *Annals of Operations Research*, 324. doi:10.1007/s10479-021-04484-4
- Mohammed, A., Jabbour, A., & Diabat, A. (2021, September). COVID-19 pandemic disruption: a matter of building companies' internal and external resilience. *International Journal of Production Research*, 61, 1-22. doi:10.1080/00207543.2021.1970848
- Mohammed, A., Yazdani, M., govindan, k., Chatterjee, P., & Hubbard, N. (2023, December). Would your company's resilience be internally viable after COVID-19 pandemic disruption?: A new PADRIC-based diagnostic methodology. *Transportation Research Part E Logistics and Transportation Review*, 180. doi:10.1016/j.tre.2023.10318
- Negri, M., Cagno, E., Colicchia, C., & Sarkis, J. (2021, April). Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. *Business Strategy and the Environment*, 30. doi:10.1002/bse.2776

- Patyal, V. S., Sarma, P. R., Modgil, S., Nag, T., & Dennehy, D. (2022, January 01). Mapping the links between Industry 4.0, circular economy and sustainability: a systematic literature review. *Journal of Enterprise Information Management*, 35, 1-35. doi:10.1108/JEIM-05-2021-0197
- Pavlov, A., Ivanov, D., Dolgui, A., & Sokolov, B. (2017, December). Hybrid Fuzzy-Probabilistic Approach to Supply Chain Resilience Assessment. *IEEE Transactions on Engineering Management*, PP, 1-13. doi:10.1109/TEM.2017.2773574
- Pimenta, M. L., Cezarino, L. O., Piato, E. L., da Silva, C. H., Oliveira, B. G., & Liboni, L. B. (2022). Supply chain resilience in a Covid-19 scenario: Mapping capabilities in a systemic framework. *Sustainable Production and Consumption*, 29, 649-656. doi:https://doi.org/10.1016/j.spc.2021.10.012
- Piya, S., Shamsuzzoha, A., & Khadem, M. (2022). Analysis of supply chain resilience drivers in oil and gas industries during the COVID-19 pandemic using an integrated approach. *Applied Soft Computing*, 121, 108756. doi:https://doi.org/10.1016/j.asoc.2022.108756
- Ponomarov, S. Y., & Holcomb, M. C. (2009). *Understanding the concept of supply chain resilience*. doi:10.1108/09574090910954873
- Ribeiro, J., & Barbosa-Povoa, A. (2022, February). A responsiveness metric for the design and planning of resilient supply chains. *Annals of Operations Research*, 324, 1-53. doi:10.1007/s10479-022-04521-w
- Sauer, P., Silva, M., & Schleper, M. (2022, May). Supply chains' sustainability trajectories and resilience: A learning perspective in turbulent environments. *International Journal of Operations & Production Management*. doi:10.1108/IJOPM-12-2021-0759
- Scholten, K., & Schilder, S. (2015, January 01). The role of collaboration in supply chain resilience. *Supply Chain Management: An International Journal*, 20, 471-484. doi:10.1108/SCM-11-2014-0386
- Scholten, K., Sharkey Scott, P., & Fynes, B. (2019, January 01). Building routines for non-routine events: supply chain resilience learning mechanisms and their antecedents. *Supply Chain Management: An International Journal*, 24, 430-442. doi:10.1108/SCM-05-2018-0186

- Sheffi, Y., & Rice, J. (2005, September). A Supply Chain View of the Resilient Enterprise. *MIT Sloan Management Review*, 47.
- Shishodia, A., Sharma, R., Rajagopal, R., & Munim, Z. (2021, December). Supply chain resilience: A review, conceptual framework, and future research. *The International Journal of Logistics Management*. doi:10.1108/IJLM-03-2021-0169
- Silva, M. E., Pereira, M. M., & Hendry, L. C. (2023, January 01). Embracing change in tandem: resilience and sustainability together transforming supply chains. *International Journal of Operations & Production Management*, 43, 166-196. doi:10.1108/IJOPM-09-2022-0625
- Sodhi, M., Tang, C., & Willenson, E. (2021, February). Research opportunities in preparing supply chains of essential goods for future pandemics. *International Journal of Production Research*, 61, 1-16. doi:10.1080/00207543.2021.1884310
- Spieske, A., & Birkel, H. (2021, June). Improving supply chain resilience through industry 4.0: A systematic literature review under the impressions of the COVID-19 pandemic. *Computers & Industrial Engineering*, 158, 107452. doi:10.1016/j.cie.2021.107452
- Spieske, A., Gebhardt, M., Kopyto, M., Birkel, H., & Hartmann, E. (2023). The future of industry 4.0 and supply chain resilience after the COVID-19 pandemic: Empirical evidence from a Delphi study. *Computers & Industrial Engineering*, 181, 109344. doi:https://doi.org/10.1016/j.cie.2023.109344
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, 14, 207–222. doi:10.1111/1467-8551.00375
- Wieland, A., & Durach, C. (2021, March). Two perspectives on supply chain resilience. *Journal of Business Logistics*, 42. doi:10.1111/jbl.12271
- Wieland, A., Stevenson, M., Melnyk, S., Davoudi, S., & Schultz, L. (2023, January). Thinking differently about supply chain resilience: what we can learn from social-ecological systems thinking. *International Journal of Operations & Production Management*, 43. doi:10.1108/IJOPM-10-2022-0645

- Zamani, E. D., Smyth, C., Gupta, S., & Dennehy, D. (2023, August 01). Artificial intelligence and big data analytics for supply chain resilience: a systematic literature review. *Annals of Operations Research*, 327, 605-632. doi:10.1007/s10479-022-04983-y
- Zouari, D., Ruel, S., & Viale, L. (2021, January 01). Does digitalising the supply chain contribute to its resilience? *International Journal of Physical Distribution & Logistics Management*, 51, 149-180. doi:10.1108/IJPDLM-01-2020-0038

Author's Statement:

I hereby expressly declare that, according to the article 8 of Law 1559/1986, this dissertation is solely the product of my personal work, does not infringe any intellectual property, personality and personal data rights of third parties, does not contain works/contributions from third parties for which the permission of the authors/beneficiaries is required, is not the product of partial or total plagiarism, and that the sources used are limited to the literature references alone and meet the rules of scientific citations.