

RESILIENCE AND SUSTAINABILITY: TRADE-OFFS IN SUPPLY CHAIN IMPLEMENTATION

Björn Bresk

University of Library Studies and Information Technologies

Abstract: Resilience and sustainability are nowadays essential parts for supply chains. To achieve both of them strategies have to be implemented within the supply chain. What barriers are impeding for one of the concepts when implementing the other and what strategies have a negative impact for both of them needs to be clarified. With help of a systematic literature review existing barriers are identified. Important managerial and practical insights are obtained from the results.

Keywords: Resilience, Sustainability, Supply Chain, Barriers.

Introduction

Ongoing globalization and the associated opening of international trade are leading to more interconnected and complex supply chains and greater vulnerability to risks and disruptions [1]. In order to respond to and recover from these risks and resulting disruptions as quickly as possible by maintaining operations, supply chains must have sufficient resilience [2]. Another key factor for supply chains, especially due to global changes, is sustainability and its three dimensions, which have received increased attention in recent years [3].

A supply chain management, which on the one hand is supported by a risk management that implements appropriate technical, personnel and organizational strategies for both ordinary and extraordinary risks or disruptive events [4], [5] and on the other hand by a sustainability management “integrating profit, people and the planet into the culture, strategy, and operations of companies.” [6], is intended to help make the supply chain more resilient and sustainable.

Resilience can be understood as “the capability of supply chains to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one.” [7] For [8], the competitive character must also be considered since resilience is additionally understood as the “[...] ability of some supply chains to recover [...] more effectively than others”.

Sustainability is understood as “sustainable development [...] that meets the needs of the present without risking that future generations will not be able to meet their own needs” [9]. Due to the interdisciplinary nature

of the sustainability concept, the three dimensions of sustainability, ecology, economy as well as social – also called Triple Bottom Line (TBL) – are to be developed equally [10].

[11] shows that there are three different possible relationships between the two concepts. The first relationship assumes that resilience is considered a component of sustainability. Here, the pursuit of sustainability is seen as the primary goal, with resilience being considered an essential component to achieving this goal. The second relationship assumes that sustainability is considered a component of resilience. In this approach, the resilience of the system or supply chain is sought as the final goal, with the process of achieving sustainability as a way to accomplish this [11], [12]. Here, it is assumed that improving systemic sustainability will lead to resilience improvements within the supply chain. The third option considers sustainability and resilience to be independent of each other. Neither sustainability contributes to resilience nor resilience contributes to sustainability [11].

Which barriers result from the implementation of one of the two concepts for the respective other and which barriers exist for both concepts at the same time will be shown in the next chapters. To this end, we will first provide an overview of the methodological approach and afterwards present the results of the study and the conclusions to be derived from them.

Research methodology

To fill the research gap, a systematic literature review was conducted. This was done on the basis of the process proposed by [14].

Previous research in the implementation of resilience and sustainability strategies and what the risks and barriers are were conducted separately for resilience strategies on the one hand and sustainability strategies on the other. Literature reviews regarding resilience barriers have been conducted by [7] and [15], among others, and regarding implementation barriers of sustainability strategies by [16], [17] and [18] among others. The third of the bilateral relationship options identified by [11], that of mutual independence, was disregarded here as it is predominantly applied in the civil infrastructure sector [19].

To identify suitable literature, appropriate search terms and their combination were used to search the databases, Mendeley and Emerald (Table 1).

Table 1. Databases and search terms

Database	Search terms
Mendeley & Emerald	resil* AND sustain* AND supply chain
	resil* AND green* AND supply chain
	resil* AND closed loop AND supply chain
	resil* AND nachhaltig* AND supply chain

The initial search was conducted using the title, abstract, and keywords of the articles. The following criteria were included (Table 2).

Table 2. Criteria of the systematic literature research

Criteria	Description
Timeframe	2003 – 2022-Q1
Language	English AND German
Content	Physical Supply Chains
Specifics	Closed-loop supply chain. Based on its inherent structure, this focuses on sustainability and is particularly suitable for the research question.

A funnel analysis was then performed to identify 32 sources suitable for analysis (see fig. 1).

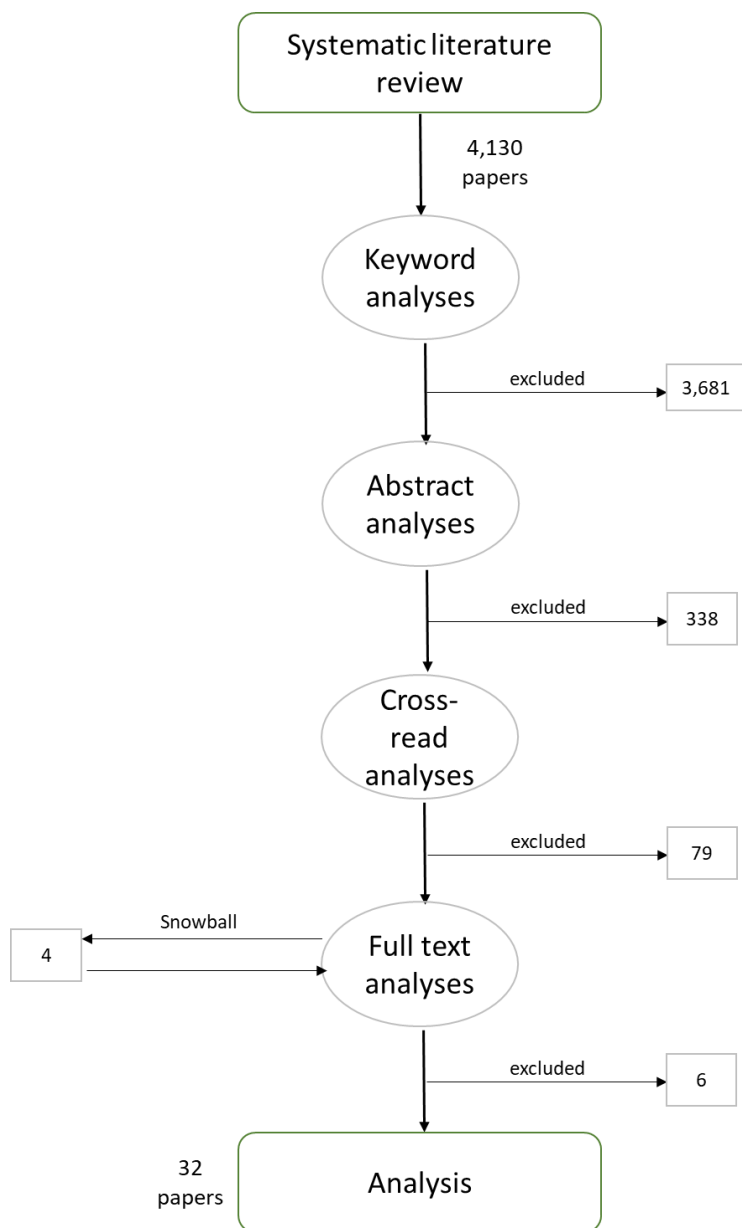


Figure 1. Overview over the literature review process

The barriers that were identified and elaborated as a result of the systematic literature review are shown below.

Results

In the course of the systematic literature analysis, 41 barriers were recorded and identified. The barriers were assigned as the main categorization on the laid focus of the strategy. In addition, the barriers within the selected strategies were assigned to the three main origins: SC Structure, SC Stakeholders, as well as SC Environment.

By implementing resilience-oriented strategies, eight problems arise for the introduction of sustainability-oriented measures. The strategies aim at a structurally more resilient design of the supply chain, which contradicts the efficiency-oriented sustainability principles by e.g., multiple sourcing or the build-up of storage capacities. Furthermore, certain behavioral patterns of SC actors involved lead to problems, e.g., when management prefers resilience to sustainability of the supply chain.

On the other hand, eight barriers to resilience actions are caused by the pursuit of sustainability along the supply chain. Increasing efficiency and considering sustainable performance along the entire supply chain reduces redundancy and flexibility. In addition, systemic resilience is deteriorated by new sustainable guidelines and standards.

Similarly, 25 barriers to resilience and/or sustainability measures have been identified. Decision makers have to define which strategies they will follow or accept along the supply chain, especially in the design of the supply chain, since, for example, advantages or disadvantages for the two concepts have to be considered when selecting the location of SC units. It must also be decided which role will be taken in the age of digitalization, as this will provide additional transparency. Furthermore, environment-related factors such as international regulations or labor market conditions influence the traceability of the two concepts. The most serious problem area, however, lies with the SC stakeholders, as their opinions and actions can cause far-reaching consequences for the supply chain and strategy implementation, whether through a lack of qualifications and the resulting misjudgments or through resentment toward certain issues.

Tables 3–5 below provides an overview and the trade-off areas of the barriers identified.

Table 3. Barriers through focus strategy resilience

Prevalent Strategy: Resilience	Barrier / Activity	Trade off area				Source
		Ecol.	Econ.	Soc.	Res.	
Origin of barrier / restrictive activity: Structure	Over-resilient design	x	x	x		[12], [21], [22]
	Global supplier / process distribution			x		[12], [22]
	Closure of non-essential business units	x				[21]
	Transport flexibility	x				[23]
	Different time horizons	x	x	x		[24]
Environment	Pricing pressure	x		x		[25]
Stakeholder	Internal strategy hierarchy	x				[26]
	Missing management knowledge about sustainability benefits	x	x			[28]

Table 4. Barriers through focus strategy sustainability

Prevalent Strategy: Resilience	Barrier / Activity	Trade off area				Source
		Ecol.	Econ.	Soc.	Res.	
Origin of barrier / restrictive activity: Structure	Code of Conduct / Green Contracts / Lack of supplier flexibility				x	[21], [25], [28], [29]
	Local supplier distribution				x	[22], [30]
	Resource efficiency / optimization				x	[22], [31]
	Waste minimization				x	[31]
	Excessive cost efficiency				x	[29]
Environment	Introduction of environmental standards				x	[23]
Stakeholder	Environmental protection guidelines				x	[32]
	Long-term partnerships				x	[29]

Table 5. Barriers for focus strategy resilience and sustainability

Prevalent strategy: Resilience & Sustainability	Barrier / Activity	Trade off area				Source
		Ecol.	Econ.	Soc.	Res.	
Origin of barrier / restrictive activity: Structure	Geographical location of SC units	x	x	x	x	OC*
	Replenishment frequency	x	x	x	x	[31]
	Insufficient data processing methods	x	x	x	x	[33]
	Insufficient communication with public authorities	x	x	x	x	OC
Environment	No substitutability of materials & raw materials	x		x	x	[34]
	Missing international standards	x	x	x	x	[35]
	Unstable labour market	x	x	x	x	OC
	Lack of local qualification level	x	x	x	x	OC
Stakeholder	Missing internal employee education and training	x	x	x	x	[36]
	IT transformation challenges	x	x	x	x	[35]
	Missing management commitment	x	x	x	x	[37]
	Wrong corporate culture	x		x	x	[38]
	Employee exposure		x	x	x	[39]
	One-sided information	x		x	x	OC

	concealment by suppliers					
	Overconfidence in theory	x	x	x	x	[28]
	Missing foresight	x	x	x	x	[30]
	Innovation restraint	x	x	x	x	[33]
	Misjudgments due to lack of qualification	x	x	x	x	OC
	Holding on to tradition	x	x	x	x	OC
	Too much investment required	x	x	x	x	[35]
	Insufficient exchange of information / lack of transparency	x	x	x	x	[11], [35]
	Trust deficit between the SC partners	x	x	x	x	OW
	Misjudgments of risk	x	x	x	x	[40]
	No standardization of risk classes	x	x	x	x	OC
	Unattractive remuneration system	x	x	x	x	[41]

Conclusion

In the previous chapters, an overview of the topics of resilience and sustainability and their interplay and significance for supply chains was presented. In today's globalized environment, supply chains need to incorporate these two concepts into their considerations, otherwise both short- and long-term survival will be threatened. In doing so, the supply chain and its decision makers face a number of challenges and barriers, as certain strategic objectives and their necessary measures are contrary to either one or both concepts.

What is needed to make the topic addressed here even more tangible for organizations and their managers will have to be investigated further in the future.

In the environment of the interplay between resilience and sustainability, little research has been conducted to date that examines the real-world adoption of the two concepts along a supply chain. Further research could help to understand how the barriers highlighted earlier impact the processes, actions, and behaviors of actors in a supply chain under real-world conditions, and whether it can be concluded that attempting to implement both concepts simultaneously is feasible.

So far, only a few efforts have been made to find out which measures and instruments equally improve resilience and sustainability and thus make it possible to overcome the existing barriers. In this regard, the elaboration of appropriate KPIs and performance measures can help to better understand existing relationships between the two concepts and to better interpret the results accordingly [42].

Moreover, different industries and their separate characteristics can be elaborated through inter- or intra-sectoral research and whether certain barriers to resilience and sustainability appear stronger or weaker for these industries [43].

With the help of a systematic literature analysis, the existing research gap was closed as to which barriers are caused by the two concepts of resilience and sustainability for each other on the one hand, and on the other hand which barriers exist for both objectives equally. The elaborated results should help decision makers in companies and supply chains to identify potential impacts of their strategies and actions at an early stage and to implement appropriate countermeasures or alternative strategies if necessary.

References

1. **Gurtu, A. & Johnny, J.** Supply Chain Risk Management: Literature Review. // *Risks*, Vol. 9(1), 1 – 16, 2021.
2. **Ponomarov, S. & Holcomb, M.** Understanding the concept of supply chain resilience. // *The International Journal of Logistics Management*, Vol. 20(1), 124 – 143, 2009.
3. **Juettner, U., Windler, K., Podleisek, A., Gander, M. & Meldau, S.** Implementing supplier management strategies for supply chain sustainability risks in multinational companies. // *The TQM Journal*, Vol. 32(5), 923 – 938, 2020.
4. **Wieland, A. & Wallenburg, C.** Dealing with supply chain risks: Linking risk management practices and strategies to performance. // *International Journal of Physical Distribution & Logistics Management*, Vol. 42(10), 887 – 905, 2012.

5. **Kersten, W., Hohrath, P., Boeger, M. & Singer, C.** A Supply Chain Risk Management process. // *International Journal of Logistics Systems and Management*, Vol. 8(2), 152 – 166, 2011.
6. **Kleindorfer, P., Singhal, K. & Van Wassenhove, L.** Sustainable Operations Management. // *Production and Operations Management*, Vol. 14(4), 482 – 492, 2005.
7. **Roberta Pereira, C., Christopher, M. & Lago da Silva, A.** Achieving supply chain resilience: the role of procurement. // *Supply Chain Management*, Vol. 19(5/6), 626 – 642, 2014.
8. **Jüttner, U. & Maklan, S.** Supply chain resilience in the global financial crisis: an empirical study. // *Supply Chain Management: An International Journal*, Vol. 16(4), 246 – 259, 2011.
9. **Hauff, V.** Unsere gemeinsame Zukunft : der Brundtland-Bericht der Weltkommission für Umwelt und Entwicklung. Greven: Eggenkamp, 1987.
10. **Hofmeister, S.** Nachhaltigkeit. In H. Blotevogel (Hrsg.), *Handwörterbuch der Stadt- und Raumentwicklung*, 2018, 1587 – 1602. Hannover: ARL – Akademie für Raumforschung und Landesplanung.
11. **Marchese, D., Reynolds, E., Bates, M., Morgan, H., Spierre Clark, S. & Linkov, I.** Resilience and sustainability: Similarities and differences in environmental management applications. // *Science of The Total Environment*, Vol. 613 – 614, 1275 – 1283, 2018.
12. **Zavala-Alcivar, A., Verdecho, M.-J. & Alfaro-Saiz, J.-J.** A Conceptual Framework to Manage Resilience and Increase Sustainability in the Supply Chain. // *Sustainability*, Vol. 12(16), 6300, 2020a.
13. **Balugani, E., Butturi, M., Chevers, D., Parker, D. & Rimini, B.** Empirical Evaluation of the Impact of Resilience and Sustainability on Firms' Performance. // *Sustainability*, Vol. 12, 1742, 2020.
14. **Tranfield, D., Denyer, D. & Smart, P.** Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. // *British Journal of Management*, Vol. 14(3), 207 – 222, 2003.
15. **Rajesh, R.** Measuring the barriers to resilience in manufacturing supply chains using Grey Clustering and VIKOR approaches. // *Measurement*, Vol. 126, 259 – 273, 2018.
16. **Movahedipour, M., Zeng, J., Yang, M. & Wu, X.** Supply-chain sustainability barriers: An empirical assessment. // *Human Systems Management*, Vol. 37(1), 27 – 43, 2018.
17. **Sajjad, A., Eweje, G. & Tappin, D.** Sustainable Supply Chain Management: Motivators and Barriers. // *Business Strategy and the Environment*, Vol. 24(7), 643 – 655, 2015.
18. **Al Zaabi, S., & Al Dhaheri, N.** Analysis of interaction between the barriers for the implementation of sustainable supply chain management. // *The International Journal of Advanced Manufacturing Technology*, Vol. 68(1 – 4), 895 – 905, 2013.

19. **Meacham**, B. J. Sustainability and resiliency objectives in performance building regulations. // *Building Research & Information*, Vol. 44(5 – 6), 474 – 489, 2016.
20. **Cabral**, I., **Grilo**, A., **Puga-Leal**, R. & **Cruz-Machado**, V. An information model in lean, agile, resilient and green supply chains. // 2011 IEEE 3rd International Conference on Communication Software and Networks, 776 – 780, 2011.
21. **Zavala-Alcívar**, A., **Verdecho**, M.-J. & **Alfaro-Saiz**, J. J. (2020b). Resilient Strategies and Sustainability in Agri-Food Supply Chains in the Face of High-Risk Events. In L. Camarinha-Matos, H. Afsarmanesh, & A. Ortiz, *Boosting Collaborative Networks 4.0. PRO-VE 2020. IFIP Advances in Information and Communication Technology*, Vol. 598, 560 – 570, 2020b. Cham: Springer.
22. **Karutz**, R., **Riedner**, L., **Stumpf**, L., **Robles Vega**, L. & **Damert**, M. Compromise or complement? Exploring the interactions between sustainable and resilient supply chain management. // *International Journal of Supply Chain and Operations Resilience*, Vol. 3(2), 117 – 142, 2018.
23. **Azevedo**, S., **Carvalho**, H. & **Cruz-Machado**, V. Trade-offs among Lean, Agile, Resilient and Green Paradigms in Supply Chain Management: A Case Study Approach. In J. F. Xu, *Proceedings of the Seventh International Conference on Management Science and Engineering Management Lecture Notes in Electrical Engineering*, 953 – 968, 2014. Berlin: Springer.
24. **Fiksel**, J., **Goodman**, I. & **Hecht**, A. Resilience: navigating toward a sustainable future. // *Solutions*, Vol. 5(5), 28 – 47, 2014.
25. **Fahimnia**, B., & **Jabbarzadeh**, A. A resilient and sustainable supply chain. // *ITLS: Working Paper*, Vol. 15, 1 – 37, 2015.
26. **Azevedo**, S. G., **Cruz-Machado**, V., **Hofstetter**, J. S., **Cudney**, E. A. & **Yihui**, T. Importance of Green and Resilient SCM Practices for the Competitiveness of the Automotive Industry. In S. M. Gupta, *Reverse Supply Chains – Issues and Analysis*, 229 – 252, 2013. Boca Raton: Taylor & Francis Group.
27. **Ji**, L., **Yuan**, C., **Feng**, T. & **Wang**, C. Achieving the environmental profits of green supplier integration: The roles of supply chain resilience and knowledge combination. // *Sustainable Development*, Vol. 28(4), 978 – 989, 2020.
28. **Xiong**, L., **Zhong**, S., **Liu**, S., **Zhang**, X. & **Li**, Y. An Approach for Resilient-Green Supplier Selection Based on WASPAS, BWM, and TOPSIS under Intuitionistic Fuzzy Sets. // *Mathematical Problems in Engineering*, 1761893, 2020.
29. **Ivanov**, D. New Drivers for Supply Chain Structural Dynamics and Resilience: Sustainability, Industry 4.0, Self-Adaptation. In D. Ivanov, *Structural Dynamics and Resilience in Supply Chain Risk Management*, 293 – 313, 2018a. Cham: Springer Nature.

30. **Korhonen, J. & Seager, T.** Beyond eco-efficiency: a resilience perspective. // *Business Strategy and the Environment*, Vol. 17(7), 411 – 419, 2008.
31. **Carvalho, H., Duarte, S. & Cruz Machado, V.** Lean, agile, resilient and green: divergencies and synergies. // *International Journal of Lean Six Sigma*, Vol. 2(2), 151 – 179, 2011.
32. **Kaur, H., Singh, S. P., Garza-Reyes, J. A. & Mishra, N.** (2020). Sustainable Stochastic Production and Procurement Problem for Resilient Supply Chain. // *Computers & Industrial Engineering*, Vol. 139, 105560, 2020.
33. **Edgeman, R., & Williams, J.** Enterprise self-assessment analytics for sustainability, resilience and robustness. // *The TQM Journal*, Vol. 26(4), 368 – 381, 2014.
34. **Gardner, L. & Colwill, J.** A Framework for the Resilient use of Critical Materials in Sustainable Manufacturing Systems. // *Procedia CIRP*, Vol. 41, 282 – 288, 2016.
35. **Binder, E.** (2021). Leitfaden zur Gestaltung zukünftiger Lieferketten in der deutschen Automobilindustrie: Herausforderungen und Maßnahmen in Bezug auf die beschaffungsseitigen Lieferketten. Leoben: Montanuniversität Leoben, 2021.
36. **Thaiprayoon, K., Mitprasat, M. & Jermisittiparsert, K.** Sustainability Consciousness Dimensions for Achieving Sustainability Performance in Thailand: Role of Supply Chain Resilience. // *International Supply Chain Management*, Vol. 8(5), 622 – 634, 2019.
37. **Khot, S. & Thiagarajan, S.** Resilience and sustainability of supply chain management in the Indian automobile industry. // *International Journal of Data and Network Science*, Vol. 3(4), 339 – 348, 2019.
38. **Almeida Souza, A., Rodrigues Alves, M., Macini, N., Cezarino, L. & Liboni, L.** Resilience for sustainability as an eco-capability. // *International Journal of Climate Change Strategies and Management*, Vol. 9(5), 581 – 599, 2017.
39. **Figueira, S., Cruz-Machado, V. & Nunes, I. L.** Integration of human factors principles in LARG organizations – a conceptual model. // *Work*, Vol. 41(1), 1712–1719, 2012.
40. **Ivanov, D.** Revealing interfaces of supply chain resilience and sustainability: a simulation study. // *International Journal of Production Research*, Vol. 56(10), 3507 – 3523, 2018b.
41. **Avery, G. & Bergsteiner, H.** Sustainable leadership practices for enhancing business resilience and performance. // *Strategy and Leadership*, Vol. 39(3), 5 – 15, 2011.
42. **Negri, M., Cagno, E., Colicchia, C. & Sarkis, J.** Integrating sustainability and resilience in the supply chain – A systematic literature review and a research agenda. // *Business Strategy and the Environment*, Vol. 30(7), 2858 – 2886, 2021.
43. **Azevedo, S., Carvalho, H. & Cruz-Machado, V.** LARG index: A benchmarking tool for improving the leanness, agility, resilience and greenness

of the automotive supply chain. // *Benchmarking: An International Journal*, Vol. 23(6), 1472 – 1499, 2016.

About the author

Björn Bresk has a Master's degree in international finance and controlling of University Würzburg. He is a financial and project consultant, working for an international IT company. Being involved in international projects, resilience and sustainability and their effects are a constant companion during his work.

To contact the author: bjoern.bresk@gmail.com