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The Impact of Supplier Diversification on Supply Chain Resilience in the Post-COVID Era

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ABSTRACT

Current vulnerabilities in supply chains all over the world have emerged due to the COVID-19 pandemic, many of which rest on shaky supply foundations. Thus, in this paper, we define resilience post-COVID-19 as supplier diversification and focus on diversification as risk mitigation, buffer for disruptive events, and efficiency-resilience trade-offs. Primary focus of the study is qualitative secondary research integrating empirical findings, theoretical frameworks and real-life evidence of industry practice, including automotive and pharmaceutical. Second, their diversification analysis tells us that diversification, while it protects against the externalities of systemic shocks, is costly in terms of coordination and management complexity. Resilience is shown not, as they say, in diversification but in how diversification forms a part of a digital enabler, a modular, relational frame, portfolio paradigm of need, advocating for open, visible/mobile digitization at the local-center, and secondhand tipped scanning. Openness in modulated form is proposed for resilience theory, where need is a resource and network based skill.

Introduction

The COVID-19 pandemic highlighted critical weaknesses in the global supply chains, in particular for those companies that can count on a limited supplier base. Wang et al. (2023) showed that the affected firms in China suffered a large drop in shareholder value within two weeks, continuing onto a year of worsening operating performance. Crucially, such a diversification effect among suppliers, customers and products helped buffer these negative effects during the crisis, serving as a cushion or "shock absorber" (Wang et al., 2023).

Similarly, implementing an economic reasoning, Todo (2022) examines firm-level data from Asia and demonstrates that geographic diversification of both suppliers and customers allowed firms to

substitute partners efficiently in order to increase supply chain resilience and sustain performance in the face of shocks (Todo, 2022).

Possibly supporting these empirical findings, Lin, Fan, and Shi (2021) examined 1434 Chinese manufacturing firms from March to July 2020, during the crisis caused by COVID-19. According to Lin et al. (2021), a diversified supplier base was positively related to abnormal inventory and profitability both during the disruption and recovery periods, whereas customer diversification buffered the demand shock and ensured profitability during the recovery period only.

The studies identified a common problem: A reliance on too few suppliers undercuts resilience and increases the severity of shortfalls. Supplier diversity, however, comes across as a strategic option even though there may be associated trade-offs such as higher coordination complexity and cost.

This article aims to look at supplier diversification as a resilience strategy during the post-COVID world. In particular, it focusses on how diversification buffers supply disruptions, taking into account the trade-offs involved, and how firms can successfully cope with these difficult to evaluate complexities. In addition to relying on empirical studies, the article draws from theoretical perspectives on resilience to provide a well-balanced analysis.

Literature Review

Inventory and Multi-Sourcing Approaches

Supply chain professionals have long known that resilience can be delivered through a combination of strategies from buffer inventories, flexible ganging or multi-sourcing. One way to try and achieve this, Guo adds, is through what is called multi-sourcing, or supplier diversification, in that if any disruption occurs firms are more agile to shift how and where they are making their production, according to Prachary. Compared to inventory-based buffer, diversification doesn't assume stock obsolescence costs but rather assumes the costs of increasing activity coordination and supplier management problems. Similarly to this, Yan (2023) studies diversification in the context of investment decisions and finds that multi sourcing has excellent mitigating benefits under high uncertainty at the expense of the budgetary costs for resilience investments. This perspective disentangles resilience from material structurality and makes resilience a cost rather than a structural contingency posing questions of long-term competitiveness vs transitory efficiency.

Strategies for digital-enabled diversification

Using fuzzy-set qualitative comparative analysis (fsQCA), Yin (2022) analogizes that supplier diversity and digital transformation implications of supply chain visibility platform and origination analytics (innovation) are most compatible with main digital-age supply chain combination. Interestingly, diversity alone was not always enough: a range of different digital enablers led to resiliency from different configurations. During a subsequent 2025 investigation with fsQCA, supplier differentiation was additionally revealed to commensurate with supplier centralization during certain conditions because customer differentiation and digital adoption have led to substitute in other channels. This underlines the configurational nature of resilience, which means different firms can achieve resilience through different strategically distinct combinations (Yin et al., 2025).

Reshoring and the Global Strategy for Trade and Diversification

While the literature has examined diversification at the firm level, the debate regarding this issue has recently been augmented down to the national and macro-level. The results of the IMF WP (2025) conclude that a combination of SIC import source diversification and targeted industry reshoring can improve system-level resilience. By contrasting the firm-level sourcing practises and government-led policies, the article reaches the conclusion that sourcing decisions and top-level policy incentives not only affect individual firms but have an impact on the entire supply chain and drive resilience in the countries. This policy-oriented view contrasts with Guo et al. (2024) and Yan et al. (2023) who examine the importance of diversification at the micro-level with analyses of diversification across decision scales.

Resiliency Delivered Leveraging Diversity of Suppliers

Supplier diversification has been presented many times as part of a wider package of resilience practises. A systematic review by Chowdhury & Paul (2021) defines four high-level strategies for resilience-building of which diversification is one - along with increased visibility, digitalization and managing disruption. Another reason for this variation, they explain, is that diversification seems to work best under conditions of uncertainty, and that industries requiring quality assurance, which also calls for reasonably good trust in supplier relationships, make use of less diversification than the average. Luckersmeyer (2025) reverses these findings in a study of efficiency-resilience trade-off between diversity as redundancy resulting in fragility (leaner operation) and barrage of operation which creates unnecessary complexity risking lean models like just in time production. This incredibly mirrors the core managerial dilemma: There actually is no way firm could optimise for both resiliency and efficiency simultaneously, in the principle and practice and thus, there always is a trade-off required between resiliency and efficiency.

Case Based Justifications for Diversification

And, unlike conceptual models, case studies illustrate hard evidence about what diversification strategies have looked like in practise. Celestin & Sujatha (2024) use a mixed methods research approach to examine resiliency for the manufacturing and healthcare sectors during the COVID-19 pandemic and the following geopolitical shocks. The most important such result was that supplier diversity complemented reshoring and digitalization programmes well, and cannot be separated from increased visibility and a better degree of control of supplier relationships. What their findings do achieve, contrary to strictly theoretical descriptions, is an illustration of the lived complexity of practicing diversification in an institutional context characterized by constraints in regards to regulation and logistical matters.

Post Pandemic Adjustments to the Theory of Resilience

In fact, the concept of supply chain resiliency has developed over the years. A pandemic-post literature review has found that there is a trend to move from reactive resilience (aftershocks; rebuilding procedure after the breakdown) to anticipatory resilience: a theory of anticipative postality (pro-attempts; redundancy and diversification) before shocks. In this context, supplier diversification is not regarded as an alternative approach, rather it is a component of forward planning (Haque et al. 2025). Gebhardt et al (2022) continue to make this transition explicit through distributional differences - between "buffering," defined as inventory stockpiling, and "bridging," defined as supplier diversification and collaboration. They write that bridging strategies (general production methods that allow for flexibility while sidestepping the inefficiencies of carrying lots of costly inventory) are increasing in share of post-COVID firms.

Theoretical Framework

Hence there are various complementary theoretical strands from which studies of supplier diversification and supply chain resilience may be conducted. The Resource-Based View (RBV) theorises that in the long run firms are able to compete successfully because they are able to create valuable, rare and inimitable resources. This logic is supported by supplier diversity to the extent that it increases firms' access to resources by enabling them to tap into multiple sources and different stimulus through diverse inputs, technologies, and knowledge stocks (Barney 1991). A newer Related model, the Dynamic Capabilities viewpoint focuses on a firm's ability to recombine resources in the context of fast-changing conditions, or to reconstitute and reconfigure resources (Teece, 2007), and is an extension of the RBV. A diverse set of suppliers introduces resilience to the supply chain by allowing us to respond quickly to any shocks or change in a turbulent market.

From another point of view, a supply chain consists of an inter-dependent network defining the bonds from which the robustness is derived from the structure and quality of the reference interdependencies, a view that is developed in journal papers of network analysis. A diversified network helps to mitigate the risk of centralization of network nodes and risk concentration by increasing structural fit, flexibility, or resilience (Borgatti & Li, 2009). However, Theory on Risk Management and Resilience, supports a community of processes such as redundancy, flexibility, robustness, etc. Supplier diversification is recognized as a proactive measure rather than a reactive measure to reduce the probability and effects of disruptive events in the supply chain (Christopher and Peck 2004).

Put together, supplier diversification emerges as resource-based intrinsically for firms and network-based (or constellational) extrinsically for organizational resilience, which derives operational strength from the combination of internal capabilities and external relational structures.

Methodology

Secondary qualitative research was used in this research. Resilient supplier diversification in the post-COVID period has already generated sufficient evidence of reference for conversion, through copious peer-reviewed research and industry analyses at regional and industry levels, thus deliberate backward-looking orientation was chosen for the paper. A comprehensive review of the existing literature enabled the project to efficiently synthesise available knowledge, to overcome access restrictions for primary data collection during and after the pandemic, and to make analogies between different scenarios (automotive, semiconductors, vaccinations) not feasible on the ground. The qualitative synthesis approach was chosen because theory-building analysis was needed for an interpretative analysis of mechanisms (e.g. malleability; such as diversification decreasing risk, digital tools altering governance costs), not for providing effect-size estimates (e.g. pooled single effects).

Sources were obtained from a combination of designed searches of academic databases, along with trusted policy/industry repositories. Inclusion criteria: English language publications for the period 2019-2025 that addressed supplier diversification, digital enablement and supply chain resilience and sourcing strategies in the post-COVID context; editorials without analytical content and duplicate research were not included. Eligible texts were coded deductively using a priori themes that were based on the GA outcomes (risk mitigation, efficiency-resilience trade-offs, modes of collaboration, policy/structural implications) and then inductively to ensure subthemes were derived. Study quality and relevance was assessed taking into account transparency of data analysis, methods and relevance of the results for transferability. Results: The meta-synthesis was

undertaken to combine convergent and divergent sources of evidence for the purpose of supporting the discussion and implications for management.

Discussion & Analysis

How diversification mitigates risks

Supplier diversity reduces your exposure to single point failures by diversifying your dependencies across multiple different nodes and geographies. From a viability perspective, more diversified networks offer more "degrees of freedom" for the propagation and redistribution of flows and capacity during periods of stress that accelerate the recovery process while dulling shocks (Ivanov, 2023). And from standard operations theory we know dual sourcing and contingent backup contracts are optimal (regardless of the riskier, actually more costly, steady state costs of dual sourcing) in light of optionality having true option value at the time of shock (Tomlin 2006). On a macro-level, concerns about broad de-globalization have usually been greater than warranted; rather than hunker down, firms can hedge against risks through diversification of supplier footprints and reducing concentration across countries and firms (Antras 2020). Together, these perspectives indicate diversification functioning both as insurance on the micro-level and on the system-level as a deterrent for cascades of failures.

Trade-offs: Efficient resilience: Trade-off between efficiency and resilience

The arguments for diversity are just a non-priced argument. For example, efforts must be made to maintain and expand a current large-qualified supplier base and inflated search, auditing and coordination costs; dilute discount levels; and complicate quality control. This bias is formalized by Tomlin's (2006) mitigation-versus-contingency analysis where single sourcing lean buffers is preferred under low disruption risk and expected cost advantage of multi-sourcing with contingent capacity rises with increasing disruption risk. The implication of this is that the convex benefits of diversification on resilience exist only for risks with severity value above the threshold, while for risks with severity value above the threshold, this convex benefit tends to overpower the occult cost. Management's problem therefore is not if, but how much to diversify, subject to the profile of firm risk, asset specificity, and managerial characteristics inherent in feasibility iterations that are basis for assurance requirements.

Case: Toyota: chip shortages, mRNA supply chains.

The global component shortages of the recent period also made it apparent how shortages spread from one segment of the industry to the next from 2020 to 2022. Ramani et al. (2022) translates this unprecedented situation into a way of forecasting: auto firms that rely heavily on dispersed sources of chips have been forced to remain shut down for a longer time compared to those suppliers that have substituted sources to market, while the whole networks with dispersed sources rebounded quickly. Even Toyota - the posterchild for long-term just in time - recently reversed sourcing and inventory policies to integrate some buffering with vertical integration to more effectively absorb another chip shock (HBR Editors, 2022). Like sustainment, resiliency-by-design research has posited that vaccines allow for rapid scale-up and endurance against export bans and localized supply chain breaks related to "critical input redundancies" (Trump et al., 2022) of key inputs (lipids, vials, philtres) and nodal diversification in the cold-chain. And in many cases, there are natural limits to doing so: if a large number of small suppliers were the price of a long process for qualification and complicated mechanisms for pharmacovigilance, a disproportionate concentration of risk may be an equally expensive and undesirable alternative. The most favorable

solutions integrated diversity with selective boundary buffers and achieved quality and time improvement via high level government.

Tools: artificial intelligence, blockchain and predictive analytics

Such diversification is modified if we are working with digital enabler. Exploiting AI and Big Data: While in each of these senses, risk, demand, and performance, we have argued that exploiting Big Data and AI mitigates the coordination penalty the firm faces based on the strategy adopted and forces it to multi-source suppliers to lower coordination costs (Zamani et al., 2023). For example, blockchain and smart contracts are known to help supply chain management by increasing trackability, deterring opportunism, and accelerating qualification among a broader supplier base (Sabre, Tilroe-Ayling, and Wicklund, 2019).

Transactional vs. Alto Hativa Diversification Strategies

Diversification can be carried out in a transactional (generally superficial) and in a collaborative (deeper multilateral relations) way (Schweizer & Scholten 2015): the latter will likely be better able to handle shocks - the common planning, information and problem solving allows diversion but avoids churn- and moral-risk problems and arm's length switching (Scholten & Schilder 2015). Similarly, recent studies also extend the complementary relationship between formal contracts and relationship governance for crisis management: The contract creates rules to dictate the expectation and co-levels of interest and relational capital offers contingency capital as agility (Lee et al., 2023). Criticism of the deep collaboration model has suggested, however, that it can result in lower switching speed if a partner fails and that rational, practical advice is to maintain a diversified tier-1 with a subset of core relationships and partners, with pre-qualified alternatives documented on the periphery.

Implications for Post-COVID strategic policy relations

Increasingly dispersed and selective nearshoring of critical nodes join regional diversification for post-COVID strategies. Instead of a complete breakdown of a global supply chain (as Buy With Confidence would do), what we are seeing is a regional hub carbonization for the loss of cross-border synergies, and for an international diversity of options that are hosted by ambulatory domestic models. Viability research supports the initiation towards modular network structures with agile reconfiguration possibilities: playbooks, secondary BOMs, pre-negotiated distributions-logs for firms to recombine providers as geopolitical or climatic events alter limitations (Ivanov, 2023). On the policy side, as growing numbers of investors are rewarded for geographically diversifying risk (i.e., CHIPS-like regimes), resilient capital structure for firms will still depend on smart portfolio construction, digitally managed governance, and a level of collaboration commensurate with component weight.

Managerial and Policy Implications

Supply chain diversity should be treated as a portfolio design and management process, not as a tactical decision. Alongside this, we looked at the revenue criticality of a spec. and supplier classification by their supplier risk to define thresholds for dual sourcing and qualified backups; and designing for failure by modularizing designs and therefore reducing requalification time. Estimation of the expected value tradeoff from disruption models was nevertheless qualitatively similar for multi sourcing and contingent capacity under an assumed risk increase: the propensity to use multi sourcing with contingent capacity increased (Tomlin, 2006), notwithstanding the initial divergence in the genuine cost under different strategies. The key coping strategy for larger suppliers was to make stress tests (i.e. time-to-recover/survive) institutionalized, digital control

towers (AI/BDA for sensing and performance monitoring, blockchain for multi-layer traceability), ensuring increased managerial "span of control" rather than diffusing complexity (Zamani et al., 2022; Saberi et al., 2019). Importantly however, diversification was best enabled through a network of cooperation (information, joint planning) with limited core partners, supported by pre-defined substitutorial alternatives; relational and contractual governance mechanisms can be complementary in activities related to response to and recovery from disruptions (Lee et al., 2023; Scholten and Schilder, 2015). These ideas are supported by examples from outside of finance: portfolios that utilized multiple sources of diversification and dilution and selective stoppages (as well as sufficient triggers for activation) in the case of semiconductor and COVID-19 monkeypox vaccine portfolios recovered faster and did not endure protracted drawdown (Ramani et al., 2022; Trump et al., 2022).

Instead of inadvertently choking off diversification, create a policy to grow it. Post-COVID evidence also implies a re-regionalization of production - starting from regional anchoring plus global options rather than wholesale regional de-globalization - and incentives and facilitation of trade that have to support economies of geographical dispersal rather than concentration (Antras 2020). While regional capacity can also be boosted via generously-sponsored resiliency schemes, e.g. US CHIPS initiative, they must be complemented by customs facilitation, acceptability degradation, and arrangements for pre-competitive cooperation (e.g. risk-data pool, pooled qualification) so vehicles can readily retool when required (CRS 2023). In fact, managerial playbooks and policy toolkits cluster around a congruent goal - sized diversification digitally structured and mediated in the network perimeter according to the firm's risk culture and the system's strategic and processual needs (Ivanov 2023).

Conclusion

In conclusion, supplier diversification was an necessary but not sufficient condition for COVID supply chain resiliency. While diversification, if a causal mechanism, is a very useful adaptation needed to stay resilient to shocks to the system by providing alternative pathways, sources and capacity, it is expensive in its coordination and if systemically designed, or uncontrolled in its reactivity to such, can result in an overall degradation of performance (despite rise in complexity). So the best experience is created in environments that link diversified content on top of a modular product structure that enable digital visibility and analytics - and that can be guided by a combination of deep relationships with core partners.

This paper makes a further contribution to the resilience literature for supply chain, integrating resource-based & dynamic capabilities logic, network and risk perspectives to show how diversification improves resilience (through access & adaptive capacity) and when it does not work (when switch options are restricted, or governance capacity is weak). And it provides a helpful framing - treating diversification as an optimization under uncertainty - while focusing more on what digital and contractual forms do to rationalize broader sets of suppliers.

References

1. Antràs, P. (2020). De-globalization? Global value chains in the post-COVID-19 age (NBER Working Paper No. 28115). National Bureau of Economic Research. https://doi.org/10.3386/w28115
2. Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–120. https://doi.org/10.1177/014920639101700108

3. Borgatti, S. P., & Li, X. (2009). On social network analysis in a supply chain context. Journal of Supply Chain Management, 45(2), 5–22. https://doi.org/10.1111/j.1745-493X.2009.03166.x
4. Celestin, S., & Sujatha, R. (2024). Supply chain resilience strategies in manufacturing and healthcare: Lessons from COVID-19 and geopolitical shocks. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5009982
5. Chowdhury, M. M. H., & Paul, S. K. (2021). Supply chain resilience: Systematic literature review and future research. Productivity, 62(3). https://ppipbr.com/index.php/productivity/article/download/147/138/782
6. Christopher, M., & Peck, H. (2004). Building the resilient supply chain. The International Journal of Logistics Management, 15(2), 1–13. https://doi.org/10.1108/09574090410700275
7. Congressional Research Service. (2023). Semiconductors and the CHIPS Act: The global context (CRS Report R47558). https://www.congress.gov/crs-product/R47558
8. Gebhardt, M., Grimm, J. H., & Pfohl, H. C. (2022). Proactive supply chain resilience management in the COVID-19 crisis—A conceptual framework. Sustainability, 14(10), 6139. https://doi.org/10.3390/su14106139
9. Guo, Y. (2024). Supply chain resilience: A review from the inventory management perspective. Science of the Total Environment, 921, 167652. https://doi.org/10.1016/j.scitotenv.2024.167652
10. Haque, R., Khan, M., & Uddin, S. (2025). Strategies for enhancing supply chain resilience post-pandemic: A literature review. ResearchGate. https://www.researchgate.net/publication/394644526_Strategies_for_Enhancing_Supply_Chain_Resilience_Post-Pandemic_A_Literature_Review
11. Harvard Business Review Editors. (2022, November 15). What really makes Toyota's production system resilient. Harvard Business Review. https://hbr.org/2022/11/what-really-makes-toyotas-production-system-resilient
12. International Monetary Fund. (2025). Diversifying supply chains for resilience. IMF Working Paper. https://www.elibrary.imf.org/view/journals/001/2025/102/article-A001-en.xml
13. Ivanov, D. (2023). Toward supply chain viability theory: From lessons learned through COVID-19 pandemic to viable ecosystems. International Journal of Production Research, 61(13), 4130–4147. https://doi.org/10.1080/00207543.2023.2177049
14. Lee, C.-H., Son, B.-G., & Roden, S. (2023). Supply chain disruption response and recovery: The role of power and governance. Journal of Purchasing and Supply Management, 29(3), 100866. https://doi.org/10.1016/j.pursup.2023.100866
15. Lee, C.-H., Yang, Y., & Chen, C.-W. (2023). Supply chain disruption response and recovery: The role of contractual and relational governance. Journal of Purchasing and Supply Management, 29(3), 100828. https://doi.org/10.1016/j.pursup.2023.100828
16. Lin, Y., Fan, D., & Shi, X. (2021). The effects of supply chain diversification during the COVID-19 crisis: Evidence from Chinese manufacturers. Transportation Research Part E: Logistics and Transportation Review, 155, 102493. https://doi.org/10.1016/j.tre.2021.102493
17. Lücker, F. (2025). Supply chain resilience: Balancing efficiency and robustness. Journal of Business Logistics. Advance online publication. https://doi.org/10.1177/10591478241302735
18. Ramani, V., Ghosh, D., & Sodhi, M. S. (2022). Understanding systemic disruption from the COVID-19-induced semiconductor shortage for the auto industry. Omega, 113, 102720. https://doi.org/10.1016/j.omega.2022.102720

19. Ramani, V., Hofmann, E., & Chen, H. (2022). Understanding systemic disruption from the COVID-19 pandemic: Evidence from the semiconductor shortage in the auto industry. International Journal of Production Economics, 247, 108428. https://doi.org/10.1016/j.ijpe.2022.108428
20. Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. International Journal of Production Research, 57(7), 2117–2135. https://doi.org/10.1080/00207543.2018.1533261
21. Scholten, K., & Schilder, S. (2015). The role of collaboration in supply chain resilience. Supply Chain Management: An International Journal, 20(4), 471–484. https://doi.org/10.1108/SCM-11-2014-0386
22. Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of enterprise performance. Strategic Management Journal, 28(13), 1319–1350. https://doi.org/10.1002/smj.640
23. Todo, Y. (2022). Robustness and resilience of supply chains during the COVID-19 pandemic: The role of supplier and customer diversification. The World Economy, 45(12), 3907–3926. https://doi.org/10.1111/twec.13354
24. Tomlin, B. (2006). On the value of mitigation and contingency strategies for managing supply chain disruption risks. Management Science, 52(5), 639–657. https://doi.org/10.1287/mnsc.1060.0515
25. Trump, B. D., Golan, M. S., Keisler, J. M., Cegan, J. C., & Linkov, I. (2022). Vaccine supply chain: Resilience-by-design and resilience-by-intervention. Environment Systems and Decisions, 42(1), 3–7. https://doi.org/10.1007/s10669-021-09859-z
26. Wang, Q., Zhou, H. D., & Zhao, X. D. (2023). The role of supply chain diversification in mitigating the negative effects of supply chain disruptions in COVID-19. International Journal of Operations & Production Management, 44(1), 99–132. https://doi.org/10.1108/IJOPM-09-2022-0567
27. Yan, W. (2023). Investment decision-making under supply chain disruption risk: The role of multi-sourcing. Journal of Supply Chain Resilience, 2(4). https://doi.org/10.1016/j.jscres.2023.100042
28. Yin, Y. (2022). Supply chain diversification, digital transformation, and resilience: A fuzzy-set QCA. Sustainability, 14(13), 7690. https://doi.org/10.3390/su14137690
29. Yin, Y., Zhang, L., & Chen, H. (2025). Configuration analysis of diversification and resilience using fsQCA. ResearchGate. https://www.researchgate.net/publication/362992939_Supply_Chain_Diversification_Digital_Transformation_and_Supply_Chain_Resilience_Configuration_Analysis_Based_on_fsQCA
30. Zamani, E. D., Smyth, C., Gupta, S., & Dennehy, D. (2022). Artificial intelligence and big data analytics for supply chain resilience: A systematic literature review. Annals of Operations Research, 329, 985–1008. https://doi.org/10.1007/s10479-022-04983-y
31. Zamani, E. D., Giannakis, M., Spanaki, K., & Vendrell-Herrero, F. (2023). Artificial intelligence and big data analytics for supply chain resilience: A review and research agenda. Annals of Operations Research, 329, 985–1008. https://doi.org/10.1007/s10479-022-04983-y