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Two perspectives on supply chain resilience

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Abstract

More than a decade ago, other fields started to challenge the equilibrium-focused meaning of resilience. They suggested that resilience does not just relate to the ability of a system to “bounce back” after an impeding event, but also to the capacity to adapt and transform. The operations and supply chain management literature remains surprisingly disconnected from these debates. This essay sets out to further our theoretical knowledge of what resilience means (or means to others) by disentangling two prominent perspectives of resilience—engineering resilience and social-ecological resilience—and offering an updated definition of supply chain resilience. We integrate and discuss these perspectives in the context of our understanding of the supply chain as a system. The goal is to outline the potential links and inconsistencies of these perspectives with supply chain management (SCM). From there, we seek to develop a more comprehensive understanding of what resilience means in SCM. Supply chain resilience is then no longer understood in terms of stability, but in terms of adaptation and transformation.

Keywords: Supply chain resilience; Adaptation; Transformation; Social-ecological systems

Introduction

The supply chain risk management (SCRM) literature started its journey by transferring the best practices of organizational risk management from the organization to the supply chain (Fan and Stevenson, 2018; Norrman and Wieland, 2020). These practices are focused on identifying, assessing, controlling, and monitoring all types of risk sources that could occur within an organization. Yet, there are fundamental differences between a traditional organization and a supply chain. The former system is already rather complicated, but it is legally and geographically confined, making it possible, at least in theory, to generate a complete list of risk sources. The latter system, the supply chain, is often described using the vocabulary of complexity theory (Choi et al., 2001; Nilsson, 2019). It regularly contains hundreds, if not thousands, of organizations; links between these organizations; and additional system characteristics that emerge because a complex system is more than the sum of its parts and is dynamic in nature.

Transferring traditional risk-management processes from an organization to a supply chain would lead to a substantial expansion of the list of risk sources. The concept of a *complete* inventory of risks is illusory, and any attempt to compile one therefore in vain. Moreover, according to anecdotal evidence, it is often the “black swan” events that cause most harm in the supply chain; that is, risks that have not been on the list of risk sources because they were simply overlooked (Akkermans and Van Wassenhove, 2018). The Eyjafjallajökull eruption in 2010 or the COVID-19 pandemic are examples of such risks in recent supply chain history. In sum, traditional risk-management approaches that work more or less well for an organization are not fully scalable to a system that is as complex as a supply chain.

Resilience has been advocated in many fields as a remedy that can help to deal with situations in turmoil (Gao et al., 2016). Supply chain management (SCM) jumped on the resilience bandwagon more than a decade ago and, along the way, developed a variety of insights into antecedents and the performance efficacy of resilience (e.g., Christopher and Peck, 2004; Sheffi and Rice, 2005; Pettit et al., 2010; Wieland and Wallenburg, 2013; Durach et al., 2020a). Unlike traditional SCRM approaches, resilience is focused on systemic characteristics instead of risk sources. However, upon reflection, we concur with Davoudi and her coauthors (2012, p. 299), who have researched resilience in the field of spatial planning, “that it is not quite clear [yet] what resilience means, beyond the simple assumption that it is good to be resilient.” By often having taken for granted a narrow interpretation of resilience as engineering resilience (or robustness), we fear the SCM discipline has contributed to this confusion. The objective of this essay is to broaden our understanding of resilience in an SCM context by drawing on literature from other fields with longer histories of studying resilience.

A long-running debate revolves around the different interpretations of resilience (Walker, 2020). Perhaps most prominently, Holling (1996), an ecologist, has made a distinction between what he calls *engineering resilience* and *ecological resilience*. He suggests that the former relates to *fail-safe* design, such as that needed to protect an engineered system (e.g., a nuclear power plant or an airplane), and the latter to *safe-fail* design, building on an organism’s ability to persist, adapt, and transform. Having often ignored this debate, the SCM community—this includes ourselves—has often interpreted resilience in the former way, thereby suggesting that there is one equilibrium the system should “bounce back”[1] to (Sheffi and Rice, 2005) and, thus, implicitly assuming that the supply chain behaves like an engineered system that can be fully controlled by managers.

Indeed, the way a supply chain is depicted in our textbooks or on the slides of organizational presentations certainly reminds us more of the static building plan or circuit diagram of an engineered system than the evolving behavior of an ecological system such as a forest.

This may explain why only a few attempts have so far been made to transfer the alternative interpretation of resilience as ecological resilience to supply chains. These attempts appear to be fruitful when reinterpreting supply chains; however, it is not sufficient simply to replace an interpretation as an engineered system with one as an ecological system, because this would still exclude social actors who contribute both threats to systems and to solving them. What is more suitable is an interpretation of the supply chain as a *social*-ecological system (Wieland, 2021). This

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[1] The Latin origin of the word resilience does in fact suggest that the concept relates to “jumping back.”

interpretation differs from the one in ecology by explicitly accounting for the role of social actors but resembles the ecological view in that it departs from the focus on bouncing back to a supposedly stable state or equilibrium. Sometimes it can make sense to persist. However, social actors in social-ecological systems are able—unlike plants in ecological systems—to learn and plan ahead, thus giving them the ability not only to gradually adapt, but also to guide the system's transformation (Walker, 2020). Davoudi and her coauthors (2013) point to the key difference between these interpretations of resilience:

> The emphasis on bouncing back as in engineering resilience or even forth, as in ecological resilience, fails to consider disturbance as a "window of opportunity" for transforming to a radically different and more desirable trajectory. (p. 315)

With this essay, we investigate two interpretations of resilience—engineering resilience and social–ecological resilience—and offer a new definition of resilience that seeks to further incorporate the underlying debate. These interpretations serve as the basis for the other articles published in this Special Topic Forum, which was initiated to ignite the debate about the value and drawbacks of the dominant, equilibrium-focused understanding of supply chain resilience (i.e., resilience as engineering resilience).

Two disparate perspectives on supply chain resilience

We start the discussion of the two perspectives on resilience by offering an alternative definition of resilience to the SCM community. Numerous definitions of supply chain resilience—in the sense of engineering resilience—already exist. Our alternative is therefore a definition that interprets supply chain resilience in the, so far, often-overlooked sense of social-ecological resilience (Wieland, 2021). Following previous debates in the field of ecology (Folke, 2006; Walker, 2020) we redefine supply chain resilience as follows:

> Supply chain resilience is the capacity of a supply chain to persist, adapt, or transform in the face of change.

In the following, we will explain the two disparate perspectives on resilience that have emerged in the literature and how this leads us to the conclusion that resilience in SCM deserves rethinking.

Perspective 1: Supply chain resilience as *engineering* resilience

One of the key achievements of early SCM research was helping organizations to understand better that they interact with a larger transactional environment that comprises organizations other than their own. Instead of surrendering to this environment, managers were enabled to perceive certain phenomena that lie outside of the boundaries of their own organization as part of a larger system: the supply chain. Before the emergence of SCM, organizations had to react to supply and demand uncertainties or risks without knowing what caused these observed effects. Now, by assuming the existence of the supply chain, these uncertainties can be explained by systemic phenomena such as the bullwhip effect (Lee et al., 1997) and the ripple effect (Dolgui et al., 2018).

While the unit of analysis has shifted from the organization to the supply chain, most supply chain thinking has assumed a clear cut-off between that system and its own contextual environment (Borgatti and Li, 2009); that is, a supply chain has long been assumed to be a closed system. One reason for this might be that one of the roots of SCM is, in fact, in engineering, where it usually makes sense to clearly distinguish the system to be engineered (e.g., a subway system or computer) from that system’s environment. Early writers in SCM have therefore implicitly perceived the supply chain as an engineerable system, thus assuming its components to be countable and its shape static. With this view in mind, it has been the goal of both academics and managers to sufficiently understand, design, and optimize this system. This might explain why supply chain managers, with the help of technology (e.g., blockchain: Durach et al., 2020b) or contractual agreements (e.g., regarding audits: Short et al., 2016), strive to take control over supply chain elements further and further upstream and downstream. While the hope seems to be ultimately to control the entire end-to-end system, reality teaches that this attempt seems to be, at best, very difficult.

Interestingly, it is still often assumed that the supply chain works almost like a machine, the elements of which mesh together like a fine-tuned gearbox, an understanding that is apparent in many contemporary definitions of the supply chain. A prominent example comes from Christopher (2016), who defines the supply chain as a "network of connected and interdependent organisations mutually and co-operatively working together" (p. 3). This understanding has, over time, developed from seeing the supply chain as a simple chain to seeing it as a much more complicated network. Moreover, engineered systems can be complicated, but that does not mean that engineers are unable to understand their designs and optimize their functionalities. Some research already indicates that this might not be the case for a system that is not only complicated, but also complex, in the complexity-theory sense, such as a supply chain (Tukamuhabwa et al., 2015).

Although it is now increasingly accepted that the supply chain is part of broader networks, it might be the traditional dominance in our discipline of interpreting the supply chain as an engineerable system that has led to the discipline's implicit interpretation of resilience as what Holling (1996) calls engineering resilience. This interpretation "concentrates on stability near an equilibrium steady state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property" (Holling, 1996, p. 33, building on other authors). As an example, in materials engineering, a material is resilient if it is able to recover its original shape after a deformation (Sheffi, 2005). Holling (1996) writes about engineering resilience:

> If it is assumed that only one stable state exists or can be designed to so exist, then the only possible definitions for, and measures of, resilience are near-equilibrium ones—such as characteristic return time. (p. 38)

SCM scholars with backgrounds in engineering have adopted such a view. For example, Simchi-Levi et al. (2014; 2018) have proposed two metrics to quantify the resilience of a supply chain: time-to-recovery (TTR) and time-to-survive (TTS). They define the former as "the time it would take for a particular node (such as a supplier facility, a distribution center, or a transportation hub) to be restored to full functionality after a disruption" (2014, p. 4) and the latter as "the longest time that customer service level is guaranteed if this facility is disrupted" (2018, p. 1487). To prevent disruptions from happening, organizations need to ensure that, for the nodes of their supply chains, TTR is smaller than

TTS. Only then will they remain able to serve the customer without any interruptions. Assuming that a supply chain behaves like an engineerable system means that there is one optimal state of the supply chain, that any deviation is suboptimal, and that a rapid return to normality should be strived for. The TTS/TTR approach is therefore a powerful application of resilience that takes these assumptions for granted.

The implicit assumption of engineering resilience is that the behavior of the supply chain can be described as the “behavior of a linear system, or behavior of a nonlinear system in the immediate vicinity of a stable equilibrium where a linear approximation is valid” (Ludwig et al., 1997, p. 7). In fact, in the short term, it is often reasonable to assume that there is one equilibrium state. For example, there are usually no substantial changes to the supplier structure of a supply chain within days or weeks. It might therefore be tempting to stabilize the supply chain by, for example, financially supporting a supplier that is in financial trouble. In the long term, however, the conditions that have led to the assumption that there is that one, equilibrium, steady state might change, thus making it less reasonable to return to such a state.

It might then no longer be reasonable to quickly return to normality if circumstances that lie outside of the supply chain have changed in a way that makes this “old normality” appear outdated and odd. If managers keep trying to stabilize the supply chain in a state that is no longer desirable, achieving engineering resilience becomes tedious and even meaningless. It turns out that engineering resilience promotes rigidity, which, in many cases, is in stark contrast to what would feel intuitively right. This becomes particularly apparent when larger crises (e.g., political, economic, ecological, societal, or cultural) are taken into account; these go beyond the supply chain but have an influence on its functioning. The supply chain’s rigidity might sometimes even contribute to these larger crises.

The debates about planetary boundaries (Steffen et al., 2015; e.g., boundaries relating to the biodiversity and climate crises) make it reasonable to assume that business models that rely on eternal material growth, fossil fuels, and harmful ingredients will likely have no future. If organizations were to strive for their supply chains to return to the old normality as quickly as possible, they would thereby risk their survival after all. Another example is the debate about the COVID-19 pandemic that has questioned the global division of labor based solely on cost efficiency. In the light of this debate, it may no longer make economic sense for European manufacturers to reestablish broken links to Chinese suppliers as quickly as possible.

Would it not, in fact, seem more intuitive to call the adaptability and transformability of the supply chain to new conditions “resilience,” rather than the rigid and often expensive attempt to keep the supply chain in a fixed state? Similar thoughts in ecology have led to an alternative interpretation of resilience and, although it is often implicit, some supply chain scholars have already followed this new path.

Perspective 2: Supply chain resilience as *social-ecological* resilience

Ecology was the first field to realize that an interpretation of resilience in terms of engineerable systems simply does not apply to the unique characteristics of the types of systems studied and managed in that field: that is, ecological systems.[2] The engineering interpretation of resilience would, for example, encourage resource managers to replant the same type of spruce monoculture as quickly as possible after a bark beetle invasion, because engineering resilience focuses on stabilizing an equilibrium steady state and promoting resistance to disturbance and speed of return (Folke, 2006). However, real-life examples demonstrate that this approach is usually not desirable. As a response to the failure of this approach, ecology has developed an interpretation of resilience that much better reflects the characteristics of ecological systems.

Ecological resilience is defined in terms of the “amount of disturbance that can be sustained before a change in system control and structure occurs” and “focuses on persistence, change, and unpredictability—all attributes embraced and celebrated by biologists with an evolutionary perspective and by those who search for safe-fail designs” (Holling, 1996, p. 33). Following this interpretation, resource managers attempt not to define an equilibrium steady state, but to accept that

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[2] There is a recent trend in the management literature to use the ecosystem term metaphorically for a certain set of actors that are not fully hierarchically controlled, that is, for systems that do not resemble the characteristics of real ecological systems in ecology, such as forests or biotopes (see Jacobides et al., 2018). This is not how we use the term ecological system here.

disturbances can flip a system from one regime of behavior to another (Folke, 2006). One of the consequences of ecological resilience is to leave behind attempts to stabilize monocultures, instead leaving room for experimentation; it is also acknowledged that ecological systems are too complex to be fully controlled by a manager and that they are interlinked with their contextual environment.

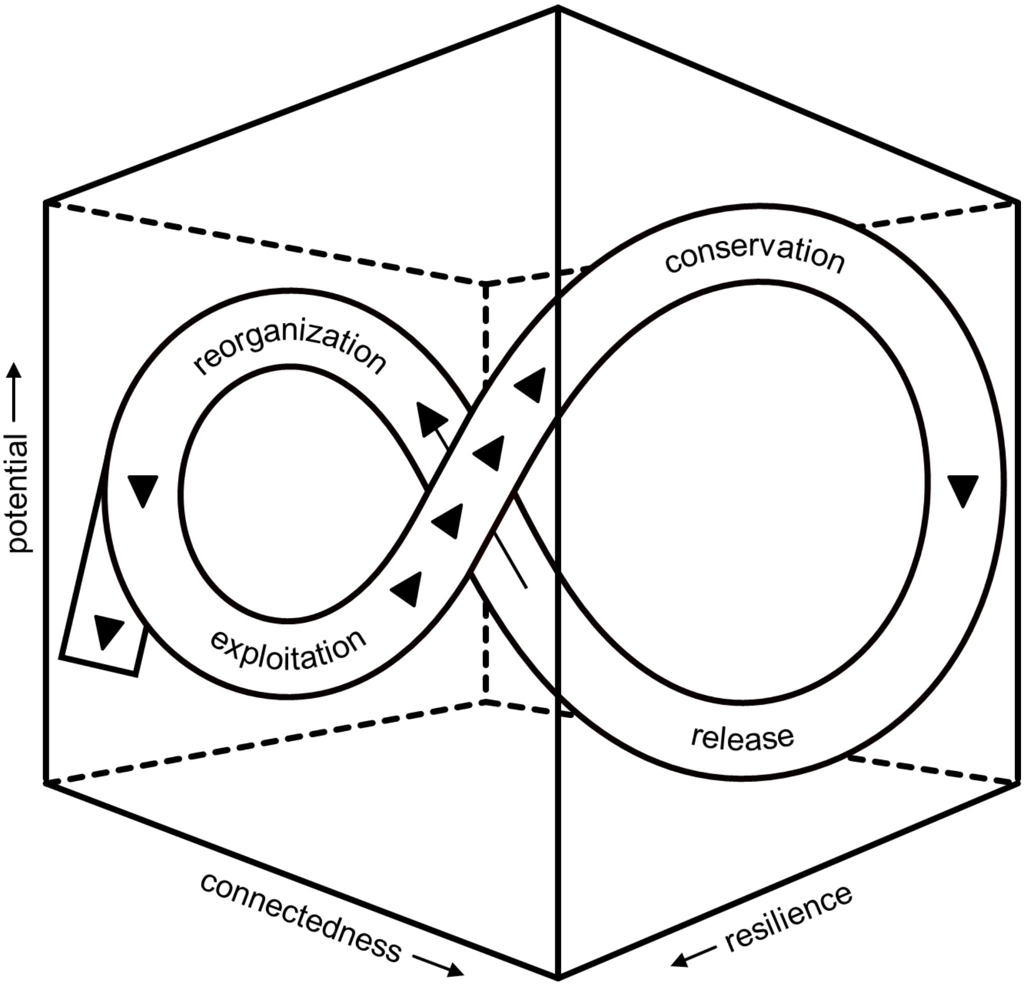

Figure 1: The adaptive cycle as a metaphor of social-ecological resilience (Wieland, 2021; based on Holling, 1986, 2001).

The ecological literature has developed the adaptive cycle model to illustrate the evolutionary adaptation of an ecological system in the three-dimensional space of potential, connectedness, and resilience (Figure 1; see Wieland, 2021, for a more comprehensive overview). *Potential* refers to the capacity for change in terms of a range of possible options that are inherent in the accumulated resources. This potential would be low for a monoculture. *Connectedness* refers to the degree of rigidity or flexibility of internal controlling variables in terms of their sensitivity to external variation (Holling and Gunderson, 2002). The adaptive cycle model predicts a slow progression from the exploitation to the conservation phase (ibid.). For an ecological system, that means, for example, that available resources will need decades to shape a forest. It is interesting to observe that the resilience of a system decreases during this transition because, by accumulating resources, the system loses options and becomes rigid. The model further predicts a very rapid progression from the conservation to the release phase, for example, because of a wildfire, and a fast further progression to the reorganization phase (ibid.). Now, new room for experimentation is available and the system is highly resilient.

Clearly, a supply chain often does not behave like an engineerable system. Machines, power plants, or subway systems might be complicated, but they are usually not complex in the sense of complexity theory and, thus, they are not erratic in their behavior. This, however, is the case for a supply chain, because of its open-system character that it has in common with an ecological system. Just like the climate crisis has unpredictable implications for a forest, shifting consumer preferences or new regulations have unpredictable implications for a supply chain. It would be bold to claim that a supply chain behaves just like an ecological system; nonetheless, as argued in Wieland (2021), we still believe that the application of the adaptive cycle model provides value to the SCM community. Holling's (1996) discovery that an ecological system requires ecological resilience has proven to be exceptionally significant and influential in his field. However, directly transferring this view to supply chain management would not do justice to the nature of supply chains. Unlike a system of nature, such as a forest, the supply chain also contains social actors. This requires features of the social sciences to be taken into account. In particular, symbolic construction or meaning plays a crucial role in a system that contains social actors (Westley et al., 2002; Wieland, 2021), such as a supply chain. Westley and her coauthors (2002) demonstrate that four elements of this dimension are helpful in understanding differences between ecological and social-ecological systems:

> The first is the creation of a hierarchy of abstraction, which loosens the power of time and space to explain social systems. The second is the inherent capacity of such meaning

> structures for reflexivity. The third is the ability to generate expectations and look forward rather than to react and look backwards in time. The final element is the ability of humans to externalize these symbolic constructions in technology, which is the equivalent of extending their energetic footprint beyond that of the typical 100-kg biped. (p. 119)

A social-ecological system is "complex, non-linear, and self-organising, permeated by uncertainty and discontinuities" (Berkes and Folke, 1998, p. 12). This view is also increasingly popular in the SCM literature, although rarely in its resilience branch. For example, Choi et al. (2001) famously proposed that it is not enough to recognize a supply chain, or supply network as they call it, simply as a system, but rather as a complex adaptive system—a view that has since strongly influenced how we interpret the supply chain as a system (Carter et al., 2015). The interpretation of systems as complex and adaptive can also be observed in other fields, especially in areas such as ecology and environmental studies. Systems linking people and nature, which are known as social-ecological systems, are often understood as complex adaptive systems (Levin et al., 2013; Day, 2014).

A social-ecological system is a special case of a complex adaptive system because it contains a set of critical resources the use and flow of which is regulated by a combination of social and ecological systems (Redman et al., 2004; Wieland, 2021). In line with the observation that resilience can operate on individual, organizational, or supply chain levels (Scholten et al., 2020), it is important to acknowledge, for example, that a supply chain is linked to other social-ecological systems that operate on other levels (e.g., the political economy or planet Earth), thereby making it impossible to manage the system in the way a closed, engineerable system could be managed.

A social-ecological interpretation of resilience is characterized not by an organization's attempts to conserve a supposedly optimal state of the supply chain but by renewal, reorganization, development, and eagerness to experiment (see Folke, 2006). It is "all about changing in order not to be changed" (Walker, 2020, p. 11). It emphasizes non-linear dynamics, uncertainty, thresholds, and surprise; how periods of rapid change interplay with periods of gradual change, and how such types of dynamics interact (Folke, 2006). Importantly, it is the task of social actors to guide the transformation of the system toward a desirable trajectory (Davoudi et al., 2013).

For example, early during the COVID-19 pandemic, the lockdown of hotels affected a Danish manufacturer of juice bottles that were typically used in conference hotels. However, given the temporary closure of those hotels, an engineering resilience approach to resume juice production as quickly as possible would not have made much sense. Instead, the organization chose to replace the production of juice with the production of hand sanitizer, which had become a scarce commodity at the beginning of the pandemic. Similarly, a German garment producer was able quickly to produce face masks and a U.S. carmaker manufactured the equipment for a medical ventilator at a factory that had to shut down during the pandemic. In some of these cases adaptation was simply motivated by the need to survive; in others it was about the company's responsibility to the community, or companies were even ordered to change. Another example is Tesla's attempt to reinvent the car in light of the climate crisis, not by mimicking the supposed optimality of combustion engine supply chains, but by assuming that the crisis would soon make such supply chains impossible, thus requiring an electric alternative.

These organizations were all able to reorganize and exploit the new opportunities that arose from the larger circumstances of a crisis. They realized that a supply chain is a complex social-ecological system and they acknowledged that it is cross-linked to other social-ecological systems that can shape what is considered normal and desirable (Wieland, 2021). Although these companies adapted to a temporary crisis, they were also able to learn and, thus, innovate in the long term. This newly gained experience might even help them to deal with much more monumental crises, such as the climate crisis. What we can also observe in these examples is that resilience should not (always) be about stability, as the engineering interpretation would suggest, but about adaptation and transformation. Social-ecological resilience has led to experiments and generated new options that are different from conventional wisdom and truths.

Conclusions

In this essay we have argued that our assumption of what a supply chain is—either a closed, engineerable system or an open, social-ecological system—leads to two polar interpretations of supply chain resilience. Engineering resilience strives for optimality and a fail-safe design; it has been measured in terms of the speed of return to an equilibrium steady state (time-to-recovery) and resistance to disturbance (time-to-survive). Social-ecological resilience allows experiments and a safe-fail design. It acknowledges that supply chains will have to change over time to remain meaningful, which requires managers to strive for adaptability and transformability, thereby foreseeing and influencing developments that occur outside of the supply chain. Social-ecological resilience is measured in terms of the magnitude of disturbance that can be absorbed before the supply chain changes its structure (Holling, 1996).

Supply chain management has strong roots in both engineering and the social sciences, but this diversity is rarely reflected in research on supply chain resilience. Our essay should not be misinterpreted as meaning that we reject the great work related to the engineering interpretation of supply chain resilience that has thus far dominated large parts of the SCM literature. On the contrary, we believe that it should be an essential skill of any supply chain manager to rapidly stabilize a supply chain in the event of a disturbance.

However, just as the *homo economicus* assumption in economics is very powerful yet fails to describe the entirety of our complex reality, the engineering assumptions in SCM are useful in the short term but still not sufficient. We believe that assuming the supply chain to behave like an engineerable system is an oversimplification of a complex reality that makes it particularly difficult to understand or predict how the supply chain interacts with the outside world. Therefore, and in line with recent calls to transplant ecological thinking into management disciplines (e.g., Ergene et al., 2020), it should also become an essential skill of supply chain managers to deal with the non-linear, uncertain, and often surprising behavior of the supply chain by adopting resilience in the social-ecological sense. And, to a certain extent, supply chains certainly still bear some of the characteristics of engineerable systems, too. Therefore, the engineering and social sciences roots of SCM need to continue to go hand in hand into the future.

We are very happy to see that several researchers have followed our call to link supply chain resilience more closely to the wider resilience debates in other fields. This JBL Special Topic Forum continues with the following articles:

Novak et al. (2021) argue that our contemporary notion of a supply chain as a complex adaptive system is misaligned with equilibrium-based conceptualizations of resilience. In fact, a supply chain continually emerges via the autonomous actions of different actors within the system. Much aligned with our own arguments, these authors offer suggestions on how researchers and practitioners can advance practice and theory by adopting a complexity-based perspective on supply chain resilience.

Wiedmer et al. (2021) explore the relationship between network complexity and the extent to which a buyer experiences a disruption and recovers from it. The authors explore ocean-level shipment data before and after the Great East Japan Earthquake in 2011, and find that different types of network complexity differently affect a buyer’s ability to resist and recover. This is interesting, as it changes our view on network complexity from a driver for supply chain disruptions to that of a factor that can also help to recover.

Finally, Rao et al. (2021) investigate the resilience of small entrepreneurs at the bottom of the pyramid. Scholars tend to research large corporations, all too often forgetting about specific socio-economic groups and their entrepreneurial contributions to our global economy, such as small shippers facilitating last-mile distributions. The authors sampled a group of entrepreneurs in India, and help us understand the factors that support those entrepreneurs to better deal with the impediments of different types of disruptions.

References

Akkermans, H., and Van Wassenhove, L. N. 2018. “Supply Chain Tsunamis: Research on Low-Probability, High-Impact Disruptions.” *Journal of Supply Chain Management* 54 (1):64–76.

Berkes, F., and Folke, C. 1998. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge, MA: Cambridge University Press.

Borgatti, S. P., and Li, X. 2009. “On Social Network Analysis in a Supply Chain Context.” *Journal of Supply Chain Management* 45 (2):5–22.

Carpenter, S., Walker, B., Anderies, J. M., and Abel, N. 2001. “From Metaphor to Measurement: Resilience of What to What?” *Ecosystems* 4 (8):765–781.

Carter, C. R., Rogers, D. S., and Choi, T. Y. 2015. “Toward the Theory of the Supply Chain.” *Journal of Supply Chain Management* 51 (2):89–97.

Choi, T. Y., Dooley, K. J., and Rungtusanatham, M. 2001. “Supply Networks and Complex Adaptive Systems: Control versus Emergence.” *Journal of Operations Management* 19 (3):351–366.

Christopher, M. 2016. *Logistics and Supply Chain Management*. 5th Ed. Upper Saddle River, NJ: FT Press.

Christopher, M., and Peck, H. 2004. “Building the Resilient Supply Chain.” *The International Journal of Logistics Management* 15 (2):1–13.

Davoudi, S., Brooks, E., and Mehmood, A. 2013. “Evolutionary Resilience and Strategies for Climate Adaptation.” *Planning Practice & Research* 28 (3):307–322.

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson et al. 2012. “Resilience: A Bridging Concept or a Dead End? ‘Reframing’ Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note.” *Planning Theory & Practice* 13 (2):299–333.

Day, J. M. 2014. “Fostering Emergent Resilience: The Complex Adaptive Supply Network of Disaster Relief.” *International Journal of Production Research* 52 (7):1970–1988.

Dolgui, A., Ivanov, D., and Sokolov, B. 2018. ”Ripple Effect in the Supply Chain: An Analysis and Recent Literature.” *International Journal of Production Research* 56 (1–2):414–430.

Durach, C. F., Wiengarten, F., and Choi, T. Y. 2020a. “Supplier–Supplier Coopetition and Supply Chain Disruption: First-Tier Supplier Resilience in the Tetradic Context.” *International Journal of Operations & Production Management* 40 (7–8):1041–1065.

Durach, C.F., Blesik, T., von Düring, M., and Bick, M. 2020b, “Blockchain Applications in Supply Chain Transactions.” *Journal of Business Logistics*, forthcoming.

Ergene, S., Banerjee, S. B., and Hoffman, A. 2020. “(Un)Sustainability and Organization Studies: Towards a Radical Engagement.” *Organization Studies*, forthcoming.

Fan, Y., and Stevenson, M. 2018. “A Review of Supply Chain Risk Management: Definition, Theory, and Research Agenda.” *International Journal of Physical Distribution & Logistics Management* 48 (3):205–230.

Folke, C. 2006. “Resilience: The Emergence of a Perspective for Social–Ecological Systems Analyses.” *Global Environmental Change* 16 (3):253–267.

Folke, C., Biggs, R., Norström, A.V., Reyers, B., and Rockström, J. 2016. “Social-Ecological Resilience and Biosphere-Based Sustainability Science.” *Ecology and Society* 21 (3):41.

Gao, J., Barzel, B., and Barabási, A. L. 2016. “Universal Resilience Patterns in Complex Networks.” *Nature* 530 (7590):307–312.

Holling, C. S. 1986. “The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change.” In *The Development of Ecological Economics*, edited by R. Costanza, C. Perrings, and C. Cleveland. Cheltenham, UK: Edward Elgar Publishing. Reprinted.

Holling, C. S. 1996. “Engineering Resilience versus Ecological Resilience.” In *Engineering Within Ecological Constraints*, edited by P. Schulze, 31–43. Washington, D.C.: National Academy Press.

Holling, C. S. 2001. “Understanding the Complexity of Economic, Ecological, and Social Systems.” *Ecosystems* 4:390–405.

Holling, C. S., and Gunderson, L. H. 2002. “Resilience and Adaptive Cycles.” In *Panarchy: Understanding Transformations in Systems of Humans and Nature*, edited by L. H. Gunderson, and C. S. Holling, 25–62. Washington, D.C.: Island Press.

Jacobides, M. G., Cennamo, C., and Gawer, A. 2018. “Towards a Theory of Ecosystems.” *Strategic Management Journal* 39 (8):2255–2276

Lee, H. L., Padmanabhan, V., and Whang, S. 1997. “Information Distortion in a Supply Chain: The Bullwhip Effect.” *Management Science* 43 (4):546–558.

Levin, S., Xepapadeas, T., Crépin, A. S., Norberg, J., De Zeeuw, A. et al. 2013. “Social-Ecological Systems as Complex Adaptive Systems: Modeling and Policy Implications.” *Environment and Development Economics* 18 (2):111–132.

Ludwig, D., Walker, B., and Holling, C.S. 1997. “Sustainability, Stability, and Resilience.” *Conservation Ecology* 1 (1):7.

Nilsson, F. 2019. “A Complexity Perspective on Logistics Management.” *The International Journal of Logistics Management* 30 (3):681–698.

Norrman, A., and Wieland, A. 2020. “The Development of Supply Chain Risk Management over Time: Revisiting Ericsson.” *International Journal of Physical Distribution & Logistics Management* 50 (6):641–666.

Novak, D., Wu, Z., and Dooley, K. 2021. “Whose Resilience Matters? Addressing Issues of Scale in Supply Chain Resilience.” *Journal of Business Logistics*. *This issue*.

Pettit, T. J., Fiksel, J., and Croxton, K. L. 2010. “Ensuring Supply Chain Resilience: Development and Implementation of an Assessment Tool.” *Journal of Business Logistics* 31 (1):1–21.

Rao, S., Deepak, I., and Rahul, L. 2021. “On Entrepreneurial Resilience among Micro-Entrepreneurs in the Face of Economic Disruptions... A Little Help from Friends.” *Journal of Business Logistics*. *This issue*.

Redman, C. L., Grove, J. M., and Kuby, L. H. 2004. “Integrating Social Science into the Long-Term Ecological Research (LTER) Network: Social Dimensions of Ecological Change and Ecological Dimensions of Social Change.” *Ecosystems* 7 (2):161–171.

Scholten, K., Stevenson, M., and van Donk, D. P. 2020. “Dealing with the Unpredictable: Supply Chain Resilience.” *International Journal of Operations & Production Management* 40 (1):1–10.

Sheffi, Y. 2005. “Preparing for the Big One.” *IEE Manufacturing Engineer* 84 (5):12–15.

Sheffi, Y., and Rice Jr, J. B. 2005. “A Supply Chain View of the Resilient Enterprise.” *MIT Sloan Management Review* 47 (1):41–48.

Short, J. L., Toffel, M. W., and Hugill, A. R. 2016. “Monitoring Global Supply Chains.” *Strategic Management Journal* 37 (9):1878–1897.

Simchi-Levi, D., Schmidt, W., and Wei, Y. 2014. “From Superstorms to Factory Fires: Managing Unpredictable Supply Chain Disruptions.” *Harvard Business Review* 92 (1–2):96–101.

Simchi-Levi, D., Wang, H., and Wei, Y. 2018. "Increasing Supply Chain Robustness through Process Flexibility and Inventory." *Production and Operations Management* 27 (8):1476–1491.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I. et al. 2015. "Planetary Boundaries: Guiding Human Development on a Changing Planet." *Science* 347 (6223).

Tukamuhabwa, B. R., Stevenson, M., Busby, J., and Zorzini, M. 2015. "Supply Chain Resilience: Definition, Review and Theoretical Foundations for further Study." *International Journal of Production Research* 53 (18):5592–5623.

Walker, B.H. 2020. "Resilience: What It *Is* and Is *Not*." *Ecology and Society* 25 (2):11.

Westley, F., Carpenter, S. R., Brock, W. A., Holling, C. S., and Gunderson, L. H. 2002. "Why Systems of People and Nature are not just Social and Ecological Systems." In *Panarchy: Understanding Transformations in Systems of Humans and Nature*, edited by L. H. Gunderson, and C. S. Holling, 103–119. Washington, D.C.: Island Press.

Wiedmer, R., Rogers, Z., Polyviou, M., Mena, C., and Chae, S. 2021. "The Dark and Bright Sides of Complexity: A Dual Perspective on Supply Network Resilience." *Journal of Business Logistics*. *This issue*.

Wieland, A. 2021. "Dancing the Supply Chain: Toward Transformative Supply Chain Management." *Journal of Supply Chain Management* 57 (1).

Wieland, A., and Wallenburg, C. M. 2013. "The Influence of Relational Competencies on Supply Chain Resilience: A Relational View." *International Journal of Physical Distribution & Logistics Management* 43 (4):300–320.