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Operational Resilience in Healthcare: A Supply Chain Perspective for Improving Healthcare Delivery

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Abstract

Healthcare systems worldwide continue to face increasing disruptions arising from pandemics, natural disasters, geopolitical instability, and supply shortages, highlighting the need for operational resilience. This study examines operational resilience in healthcare from a supply chain perspective, emphasizing its role in improving healthcare delivery and ensuring service continuity. The research explores key resilience strategies, including supplier diversification, strategic inventory management, digital supply chain technologies, and collaborative stakeholder engagement. Using evidence from existing literature, the study analyzes how these approaches enhance the ability of healthcare organizations to anticipate, respond to, and recover from disruptions while maintaining the availability of critical medical supplies and services. The findings suggest that resilient supply chain practices significantly improve operational efficiency, patient safety, resource availability, and organizational performance. The study concludes that integrating resilience-focused supply chain strategies into healthcare management is essential for building sustainable, adaptive, and responsive healthcare systems capable of delivering quality care under both routine and crisis conditions.

Keywords: *Operational Resilience, Healthcare Supply Chain, Healthcare Delivery, Supply Chain Management*

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1. Introduction

> The United States needs resilient, diverse, and secure supply chains to ensure our economic prosperity and national security. (The White House, 2021).
> Our dependencies in areas like energy and raw materials weaken us economically and politically. But we also need to rethink our supply chains from an environmental and social point of view... We need secure and sustainable supply chains(European Commission, 2022).

The healthcare supply chain (HSC) is a composite system of organizations that make essential healthcare goods and services required for treating and managing severe or chronic diseases (Senna et al., 2023; Piffari et al., 2026). Resilience is a fundamental component of healthcare supply chains, as the quality and endurance of human life are dependent on them. However, there are numerous resilience-building measures, and there is a need for prioritization of those strategies (Rehman and Ali, 2022). According to Wieland and Durach (2021) cited by Peters et al., (2023), recent Supply Chain Resilience (SCR) studies based on COVID-19 experiences have paid attention to the complexity and dynamic nature of supply chains. Single entity focused definitions of resilience have been replaced with multi-layered definitions, in which supply chains are seen as intertwined and complex networks (Ivanov and Dolgui, 2020). The static equilibrium-based view of resilience – which refers to the ability of a supply chain to "bounce back" or"forward" after a disruptive event – has been replaced with a dynamic view in which the supply network continuously evolves (Novak et al., 2021).

Supply chain resilience has been defined as "the ability to proactively plan and design the supply chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operations, if possible, more favourable than the one prior to the event, thus gaining competitive advantage" (Ponis and Koronis, 2012: 925–926). For healthcare supply chains, this would require the synchronisation and integration of the resources and capabilities of supply chain entities to ensure adequate preparedness, effective recovery and response, but most importantly, robust service delivery to healthcare workers and patients in the event of a disruption (Mandal, 2017). However, these supply chains also ought to support the well-being of its customers.Following on from these new insights on what is SCR, the next step is understanding how to organize for resilience.

This new dynamic complexity perspective on SCR and the focus on organizing for resilience calls for novel approaches in practice and research. Traditionally, supply chain management (SCM) literature has been operationally focused, and firm centered. Although there is a persistent gap in the literature is the lack of a clear definition of healthcare supply chain management (HCSCM), Larimiet al. (2026) noted that the gap distinguishes it from conventional supply chains, alongside the need to integrate sustainability and resilience into healthcare supply chain (HCSC) design and operations. Controllability, rationality, optimality, and objectivity have been the leading determinants (Wieland, 2021). Experiences in the pandemic reveal the limitations of this view. For instance, with a shared objective of health continuity during the pandemic, the importance of network (including buyer-to-buyer) coordination has been emphasized. Taking a dynamic, holistic perspective means that we must seek deeper layers of interconnectedness between operational activities and (emerging) strategies, and address the role of the interorganizational network. We endeavor to understand the governance of the network and its influences on building resilience. In doing so, this study responds to Craighead et al. (2020:838) advocating that "pandemics require scholars to

take a fresh look at what lenses offer understanding of supply chain phenomena in order to help supply chain managers better prepare for the next pandemic."

2. OperationalResilience in Healthcare from Supply Chain Perspective

The concept of resilience, defined as the ability of organizations to adapt their operations before, during, and after disruptions while ensuring the delivery of essential services, has garnered increasing attention in healthcare research (De Luca, 2025).Luca citing the studies of Barasa et al (2018) and Blanchet et al (2017) described resilience as the ability of organizations to adapt their operations before, during, and after events, ensuring the ongoing delivery of essential services under both expected and unexpected circumstances. This concept has gained significant recognition in healthcare research, as it provides a theoretical framework to understand how various disturbances can be mitigated and what constitutes quality in healthcare provision even during crises (Barbash & Kahn, 2021; Cristian, 2018; Turenne et al., 2019). By integrating concepts and approaches from disciplines such as psychology, engineering, ecology, and safety management, De Luca (2025) said, the concept of resilience enriches the healthcare field by providing new perspectives aimed at enhancing system functioning from institutional, organizational, and individual levels, ultimately facilitating high-quality and safe patient care. The healthcare system, characterized by compartmentalized structures, interactions among diverse stakeholders, and considerable variability in performance across multiple levels, demonstrates its inherent complexity even more clearly when facing crises (Aase et al., 2020; Bergami et al., 2024 in De Luca, 2025).

Therefore, interest in healthcare supply chain management research has gradually heightened over time with some of the most researched topics being in the areas of information technology and new technology in services and design of service delivery systems, capacity planning, scheduling and control (Dobrzykowski et al., 2014). Like humanitarian aid supply chain management, healthcare supply chain management differs from commercial supply chain management because healthcare is a specialised industry that needs to be prepared for instances beyond the unexpected within 'normal' supply chain operations such as large-scale sickness outbreaks, chemical/biological attacks and pandemics (VanVactor, 2011).

The analysis and insights developed in the present study would help to plan and execute a viable, resilient emergency HCSC preparedness during the emergence of any health outbreak along with the stakeholders' coordination (Hossain, Thakur and Kazancoglu, 2023).Citing the work of Rasel et al., (2022), the healthcare supply chain is one of the most important parts of the global health system. It includes all the steps from getting healthcare products and services to making them, shipping them, and delivering them. They posited further that good supply chain management (SCM) makes sure that hospitals, clinics, and pharmacies always have access to medicines, surgical tools, diagnostic devices, and other resources that can save lives. Repeated disruptions, especially during the COVID-19 pandemic, which showed structural weaknesses in global and regional distribution networks (Ivanov & Dolgui, 2020), have made it clear how important it is to optimise healthcare supply chains.

Healthcare supply chains are different from those in other fields because delays, shortages, or inefficiencies can mean life or death (Rasel et al., 2022). Healthcare logistics must finda balance between cost-effectiveness and the highest standards of quality and reliability, which is not the case with supply chains for consumer goods (Fahimnia et al., 2019). Healthcare supply chains also have problems like changing demand, strict rules, short product lifecycles, and dependence on global sourcing. Improving thesenetworks is not just about making things run more smoothly; it's also a strategic necessity for making them more resilient, cutting costs, and keeping patients safe (Kumar et al., 2021).

3. Integrated Healthcare Resilience Strategies

To maintain continuity, the HSC must be able to withstand disturbances, ranging from high-frequency-low-impact disturbances – such assuppliers' delays, quality issues and general services interruptions – to low-frequency-high-impact disturbances – such as pandemics, earthquakes, floods, famine and wars (Chopra et al., 2007; Ivanov, 2021; Oke and Gopalakrishnan, 2009; Tang, 2006). To ensure the continuity of healthcare operations and services, HSC resilience, interpreted as "the capability of the supply chain to provide uninterrupted treatments and healthcare products to patients in the event of a disturbance, consequently maintaining continuity of operations" (Mandal, 2017), is paramount. Hitherto, this interpretation of the resilience concept is limited, as it fails to recognise disturbances as an opportunity for transforming to a more desirable state than the original one (Davoudi et al., 2013; Hohenstein et al., 2015; Scala and Lindsay, 2021). Including such a transformative dimension aligns the definition of resilience to the social–ecological (S–E) perspective of resilience as discussed in Wieland and Durach (2021), where supply chain resilience is defined as the capacity of a supply chain to persist, adapt and transform in the face of change.

Whilst there is no universally accepted definition, there is the widely-held notion that SCR is about recovering from disruptive events (Novak et al., 2021). Peters et al., (2023) identified three major facts that emanated from COVID-19 that led to scrutiny of many, previously widely accepted facets of resilience. First, traditional SCR, but also more generally Supply Chain Management (SCM), are often explained through an individualistic perspective – in the majority of cases, one organization or the relationship between an organization and its suppliers is the unit of analysis. In the early 2000s, Choi et al. (2001) argued for a shift in perspective stating that"supply networks emerge rather than result from purposeful design by a singular entity" (p. 351).

Second, traditional SCR is often focused on controllability and optimality (Wieland, 2021). This is evident in pre-COVID-19 definitions of resilience as, for instance, with Kamalahmadi and Parast (2016:121)"the adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations." Phrases such as "reducing probability", "resisting the spread of disturbances", "maintaining control", "transcend the disturbance" and "restore the supply chain to a robust state" imply stability and controllability within supply chains. Rather, resilience in the post-COVID-19period is about the ability "to maintain core functionality by continually adapting, evolving, and transforming in response to the dynamic multiscale feedbacks that occur between the multitude of interconnected organizations, institutions, and social and ecological systems that are all parts of the larger supply chain" (Novak et al., 2021:10).

Third, the focus on firm, controllability and optimization lead to a linear, operational perspective rather than a holistic view which encompasses emergent, intertwined and strategically significant outcomes of network actors' distributed behaviors over time.

4. The Challenges in in Healthcare Supply Chains

Healthcare supply chains (HSCs) are inherently complex and face challenges that distinguish them from other industries (Rasel et al., 2022). The unpredictability of demand for critical medicines, diagnostic devices, and life-support equipment often leads to stockouts or overstocking (Kumar et al., 2021). Unlike consumer goods supply chains, healthcare logistics must prioritize patient safety over cost efficiency, making the stakes exceptionally high

(Chopra & Meindl, 2019). Shortages of essential items such as ventilators and vaccines during the COVID-19 pandemic highlighted how fragile healthcare supply networks can be (Ivanov & Dolgui, 2020). (Rasel et al., 2022) extensively analysed the following as inherent challenges bedeviling healthcare supply chains.

One recurring problem is demanding uncertainty. Demand forecasting in healthcare is notoriously difficult due to seasonal variations, disease outbreaks, and sudden health emergencies. Many healthcare providers rely on outdated, reactive procurement models that fail to capture real-time data. This creates inefficiencies in inventory control, particularly for perishable products like blood, vaccines, and certain pharmaceuticals. Another key challenge is procurement delays and supplier dependency. Hospitals often depend on a few global suppliers for critical drugs, which makes them vulnerable to disruptions in transportation, regulatory bottlenecks, or raw material shortages. The concentration of production in specific geographies-such as India and China for generic pharmaceuticalsexacerbates risks of global shocks.

Additionally, lack of visibility and coordination across multi-tiered healthcare networks weakens efficiency. A single hospital might manage thousands of suppliers and distributors, yet visibility into upstream inventory levels is often limited. This opacity increases risks of counterfeit products entering the supply chain, which directly threatens patient safety.

Regulatory pressures further complicate healthcare supply chains. Strict compliance requirements for handling-controlled substances, medical devices, and biologics impose constraints on procurement and distribution. Combined with environmental regulations and sustainability mandates, these requirements necessitate integrated supply-chain strategies that balance compliance with cost-effectiveness.

According to Tortorella et al (2023),when supply chains are not resilient enough to withstand disruptions, not only is the value proposition to customers severely imperilled, but in the case of healthcare supply chains, their very lives may be in danger. Findings from this research provide a good basis to instigate learning from the disruptions and reconfiguring resources and capabilities in healthcare supply chains to adapt and be in a better position than before the COVID disruptions.

5. Policy and Practice Implications

The study evidence suggests that, while many practitioners are aware of the possibly disastrous consequences of supply disruptions especially in the medical sector, they give little attention to the effects of “deep structures” and social relations that frame behaviors such as rivalry and cooperation among buyers in the network. Our analysis reveals a critical mismatch between the network-level perceived challenges and the often organization-centeredproposed solutions.

Organizing for supply chain resilience requires both anticipation and containment strategies at the network level.As Berthod et al. (2017) argue, one strategy (or the absence thereof) reinforces the other. Through collaborative anticipation strategies, awareness and confidence in the network are increased, which improves relationships and the general state of preparedness. Without anticipation strategies, organizing for resilience through containment strategies is less effective.

Establishment of supply chain resilience requires stable (and potentially dormant) working relationships characterized by trust between all key actors in the supply network. This includes the buyer network.It is pertinent to understand resilience failures and opportunities

to develop resilience, it is necessary to look beyond specific product supply chains and atomized buying organizations to buyer networks. In a pandemic, different institutions act in the same market – in our case, with the same goal – to supply medical equipment to ensure healthcare continuity. Operating in the same market makes buyers either Allies or competitors

Decisive supply chain resilience requires a clear – though not necessarily unitary and hierarchical – basis of command underpinned by experience-based legitimacy, which allows for layering and switching of governance modes to achieve effective forms of network governance, both in times of stability and crisis.Organizing for supply chain resilience requires effective network governance. Different governance approaches are needed in stable times than in times of crisis. Through layering and switching, the most effective form of governance can be achieved – either supportive governance in stable times, or assertive governance in times of crisis. Supportive network governance means rotating responsibilities, a participative decision structure, and experience-based legitimacy, whereas assertive network governance requires consulting arrangements, with clear command and decision structures (Berthod et al., 2017), with one or more organization(s) coordinating the network in times of crisis

6. Conclusion and recommendations

The study maintained that sustainable and resilient HCSCM requires a broad, stakeholder-inclusive approach to support patient care, scalability, and operational performance. It discussed the policy implications that illustrates the complex relationship between sustainability and resilience in health care supply chain (HCSCs), especially under crisis and persistent operational challenges.

As more and more disruptions have shown that the implementation of conventional supply chain management optimisation techniques has made supply chains more vulnerable, the interest in ensuring supply chains are resilient both in research and practice has increased (Tortorella et al., 2023). The COVID19 pandemic accentuated this. For healthcare supply chains, the added component of the risk to human lives in the event of disruption further heighten the non-negotiability of their resilience.

The study advocates for strategies such as diversified sourcing, transparent communication, proactive climate threat measures, and targeted adoption of technological advancements. The insights from this paper offer coherent conceptualization and decision-relevant guidance for practitioners, researchers, and policymakers.

Organizing for supply chain resilience requires a clear – though not necessarily unitary and hierarchical – basis of command underpinned by experience-based legitimacy, which allows for layering and switching of governance modes to achieve effective forms of network governance, both in times of stability and crisis.

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