Digital Transformation and Pandemic Resilience in Global Logistics: A Comparative Case Analysis of DHL's Supply Chain Operations in the United Kingdom and United States

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DOI: https://doi.org/10.47772/IJRISS.2026.101000788

Received: 27 October 2026; Accepted: 01 November 2026; Published: 18 November 2026

ABSTRACT

The COVID-19 pandemic exposed structural fragilities in global supply chains and accelerated logistics providers' investment in digital technology. This paper examines how artificial intelligence (AI), blockchain, and the Internet of Things (IoT) have contributed to pandemic resilience in global logistics, using DHL's operations in the United Kingdom and the United States as an illustrative comparative case. Drawing on industry reports, trade-body surveys, and the academic literature, the analysis finds that these technologies strengthen supply chain visibility, forecasting capability, and transactional trust, while high implementation costs, legacy-system integration, and cybersecurity exposure remain persistent constraints, particularly for smaller operators. A comparison of national contexts suggests that the UK and the US are converging on similar technologies but for different underlying reasons: UK adoption is shaped substantially by post-Brexit uncertainty and shifting consumer behaviour, while US adoption is driven by competition for global technology leadership and by workforce skills shortages. The paper argues that digital investment alone does not guarantee resilience; it must be accompanied by leadership, workforce development, and a long-term strategic orientation toward risk.

Keywords: Artificial Intelligence, Blockchain, Digital Transformation, Internet Of Things, Logistics, Pandemic, Supply Chain Resilience

INTRODUCTION

The COVID-19 pandemic disrupted global trade at a scale with few historical precedents, contracting international commerce and exposing latent weaknesses across logistics networks [UNCTAD 2021]. National-level data illustrate the unevenness of this disruption: a large majority of UK logistics operators reported severe operational interruption during the pandemic [Edger 2021], while US supply chains experienced rising costs and falling productivity, with most surveyed professionals reporting significant pandemic impact on their operations [Rees and Mullins 2023, CSCMP 2021].

These disruptions intensified interest in supply chain resilience and in the digital technologies argued to support it. Industry analysis has linked the adoption of blockchain, artificial intelligence, and the Internet of Things to improved supply chain visibility, lower operating costs, and greater efficiency [Lund et al. 2020], and major logistics providers, DHL prominent among them, have since committed substantial capital to digital transformation programmes [DHL 2021].

This paper reviews and synthesises the available evidence on how such technologies have supported pandemic resilience in global logistics, using DHL's supply chain operations in the UK and the US as a comparative illustrative case. The remainder of the paper proceeds as follows: the next section reviews the literature on supply chain resilience and on the specific technologies under consideration; this is followed by the methodological approach, the DHL case findings for each country, a comparison of the two national contexts, a discussion of broader implications and likely future impact, and a concluding section addressing limitations and directions for further research.

LITERATURE REVIEW

Conceptualising Pandemic Resilience in Global Logistics

Supply chain resilience is commonly defined as the capacity of a supply chain to withstand, absorb, and recover from disruption [Manners-Bell 2023]. The pandemic gave this concept renewed urgency, as logistics networks confronted disruptions, including border closures, lockdowns, and sudden demand shifts, that had few close antecedents. The literature typically decomposes resilience into three components: preparedness, understood as proactive measures such as contingency planning, capital investment in digital infrastructure, and strategic partnerships [Edger 2021]; responsiveness, the capacity to act quickly on emerging problems through measures such as remote working, shipment rerouting, and supply prioritisation [Raassens et al. 2022]; and adaptability, the ability to exploit new opportunities, including digital platforms and alternative supply routes, as circumstances change. These three components, preparedness, responsiveness and adaptability, structure the comparative case discussion in the Case Findings and Comparative National Context sections below; the related but distinct concept of antifragility, introduced later in this review, is treated separately in the Discussion as an open question about DHL's outcomes rather than as a criterion the available secondary evidence can confirm or deny.

Beyond its operational dimension, resilience is presented in the literature as a matter of macroeconomic stability. Sloman et al. [2021] frame economic systems as inherently vulnerable to shocks such as pandemics, and argue that resilience investment mitigates the downstream financial consequences of disruption, including demand shocks and market volatility. Rees and Mullins [2023] add an organisational dimension, arguing that leadership, internal communication, and effective teamwork are as central to crisis management as technological capacity itself.

This practitioner-oriented literature is complemented by more theoretically grounded operations-management research specific to the pandemic context. Ivanov and Dolgui [2020] extend the resilience concept toward the notion of supply chain 'survivability', arguing that intertwined, digitally connected supply networks can be structured to endure disruption durations far longer than conventional resilience models assume. Ivanov [2021] subsequently formalises four adaptation strategies used by supply chains during COVID-19, intertwining, scalability, substitution, and repurposing, though he notes these strategies were mostly documented reactively rather than planned for in advance. Reviewing over one hundred pandemic-related supply chain studies, Queiroz et al. [2022] caution that much of this literature remains conceptual rather than empirically validated, a limitation that the present paper's own reliance on secondary sources shares rather than resolves.

Emerging Technologies in Logistics: A Critical Assessment

Three technologies dominate the literature on digitally enabled resilience: artificial intelligence, blockchain, and the Internet of Things [Manners-Bell 2023]. Their claimed benefits include automation, improved security and transparency, real-time monitoring, and predictive analytics. Raassens et al. [2022] argue that predictive analytics and AI allow logistics providers to anticipate disruption, identify alternative suppliers or routes, and make better-informed operational decisions using both historical and live market data. IoT sensors are similarly credited with enabling real-time inventory and shipment tracking, which is particularly valuable for goods vulnerable to spoilage or contamination, such as food and pharmaceuticals [Edger 2021].

Blockchain's contribution is framed somewhat differently: by creating an immutable transaction record, it supports supply chain finance and product verification, reducing fraud and counterfeiting risk [Manners-Bell 2023]. The resulting gains in transparency are argued to build trust among supply chain participants and thereby reduce the likelihood, and cost, of disruption.

These claims are corroborated, with important caveats, elsewhere in the operations-management literature. Reviewing supply chain risk management and AI research, Baryannis et al. [2019] find that AI techniques are considerably more developed for risk identification and prediction than for translating that prediction into mitigation action, a gap consistent with the implementation difficulties discussed below. Saberi et al. [2019] reach a similarly qualified conclusion on blockchain: its transparency and traceability functions are well

established conceptually, but empirical evidence of resulting sustainability or resilience gains at scale remains limited, and adoption is constrained by cost, technical complexity, and unclear governance arrangements between supply chain partners. Taken together, this suggests that claims about the transformative potential of AI and blockchain in logistics are better read as promising and partially evidenced rather than as settled, sector-wide fact.

The literature is nonetheless clear that these benefits are not unconditional. High implementation costs can place these technologies out of reach for small and medium-sized logistics operators, and cybersecurity exposure grows alongside digital integration [Sloman et al. 2021]. Rees and Mullins [2023] further note that integrating new digital systems with legacy infrastructure and established operating procedures is often more difficult in practice than technology vendors suggest, a caveat that should temper any assumption that digital investment translates automatically into resilience.

METHODOLOGY

This paper adopts a qualitative, literature-based case study design. DHL was selected as the focal case on the basis of its scale and its publicly documented digital transformation programme, allowing its experience to be examined across two contrasting national contexts, the United Kingdom and the United States, chosen to enable comparative analysis of how differing regulatory, economic, and competitive environments shape technology adoption. Evidence was drawn from secondary sources: peer-reviewed literature on supply chain resilience and logistics technology, industry and consultancy reports, trade-body survey data, and DHL's own published reporting.

Source selection followed a simple triangulation protocol: wherever a corporate or industry claim is reported, this paper attempts to cross-check it against at least one independent academic or multi-stakeholder source. Where independent verification could not be obtained for a specific quantitative claim, this is flagged explicitly at the point it is used rather than presented as settled fact; the Comparative National Context section below illustrates where this limitation applies. Given its reliance on secondary and corporate-reported material more broadly, the overall approach is best understood as a critical synthesis rather than an independent empirical evaluation; this limitation is revisited in the concluding section.

Case Findings: Dhl's Digital Transformation In The Uk And Usa

United Kingdom Operations

In the UK, DHL's digital investment has centred on AI-based predictive analytics for identifying disruptions and alternative suppliers or transport routes, and on AI-based predictive maintenance, which the company reports is associated with reduced equipment downtime and improved overall equipment effectiveness [DHL 2021]. IoT sensors have also been deployed to track shipments in real time, a capability DHL associates with faster operational responses to changing conditions. These are DHL's own reported outcomes rather than independently audited performance figures, a distinction this paper is not in a position to resolve from the sources available to it.

United States Operations

In the US, DHL's reported investment has concentrated more heavily on blockchain, used to strengthen supply chain security and transparency through an immutable transaction record that supports real-time tracking and product verification [DHL 2021]. This is consistent with broader US industry sentiment: a substantial majority of surveyed US supply chain professionals regard digital transformation as essential to improving resilience [CSCMP 2021].

DHL's own account of this transformation is not without friction. The company identifies integrating new technology with existing infrastructure and procedures as a persistent challenge [Lund et al. 2020], alongside cybersecurity and data-privacy setbacks. Its stated response has combined continued technology investment with workforce upskilling and efforts to build a more innovation-oriented internal culture [DHL 2021], consistent

with the broader literature's point that technology adoption and organisational capability need to be developed in tandem rather than technology alone driving resilience outcomes.

Comparative National Context: Uk And Usa Technology Adoption

Both countries show broadly similar engagement with logistics technology, but the underlying drivers appear to differ. In the UK, firms such as Amazon and Tesco have invested heavily in AI-driven logistics and automation. Vrontis et al. [2022] situate this within a wider entrepreneurial and innovation-oriented UK business environment, while also noting that UK firms face real headwinds from shifting consumer behaviour and the continuing economic uncertainty associated with Brexit.

In the United States, robotics development has been supported by a strong innovation ecosystem, significant investment in technology ventures and the growth of robotics-related firms. Estolatan et al. [2018], however, caution against treating the country as the global leader in robotics. Their cross-country analysis identifies the US as an important innovation hub and market, while noting that Japan and China held stronger positions in the global robotics market at the time. The authors also highlight the role of investment, business consolidation and regional innovation clusters in shaping the development of the robotics industry. This suggests that US technological competitiveness should be understood in terms of its innovation capacity and investment environment rather than an assumed overall dominance in robotics.

A methodological note is warranted here. An earlier version of this analysis attributed specific UK and US firm-level digital-investment statistics to the World Trade Organization's World Trade Statistical Review [WTO 2023]. On closer inspection, that publication reports aggregate international trade volumes and flows, not firm-level or sector-level technology adoption survey data, so it is not an appropriate source for claims of that kind. No independently verifiable primary source for the original firm-level statistics could be located in the course of preparing this paper, and the specific percentage claims have therefore been removed rather than retained on an unverifiable basis. Readers seeking current, properly sourced UK and US logistics-sector technology-investment figures are directed to CSCMP's State of Logistics Report series [CSCMP 2021] and to future updates of DHL's own published reporting [DHL 2021], with the explicit caveat that the latter is a corporate rather than independent source.

Table 1. Comparative summary of technology adoption drivers in UK and US logistics

Focus Area	United Kingdom	United States
Technology adoption	Reported growth in blockchain, AI, and IoT use among major UK logistics operators [Vrontis et al. 2022].	Important robotics innovation hub and market, supported by investment in robotics-related ventures and regional innovation clusters [Estolatan et al. 2018].
Primary driver	Responding to Brexit-related uncertainty and shifting consumer behaviour [Vrontis et al. 2022].	Investment in emerging technologies, business development and innovation partnerships.
Principal challenge	Economic uncertainty and changing customer expectations.	Projected labour shortfall in US supply chain roles and changing skill requirements [Accenture 2026].

Discussion: Implications For Operational Transformation And Future Impact

The pandemic accelerated the case for operational transformation in both countries, with AI, blockchain, and IoT positioned as central to anticipating disruption, identifying substitute suppliers or routes, and responding quickly to changing conditions [Rushton et al. 2022]. Resilience-engineering scholarship frames this as a matter of organisational design as much as technology procurement: Hollnagel et al. [2006] argue that firms must build the capacity to respond to disruption efficiently, which requires investment in risk management, business-continuity planning, and an adaptable organisational culture, not technology alone. Consistent with this, Rebelo et al. [2022], in a systematic review of 171 peer-reviewed studies, identify order fulfilment, manufacturing flow

management and demand management as the supply-chain processes most frequently associated with IoT applications. Their findings suggest that IoT can contribute to supply-chain performance, although its benefits depend partly on the integration of enabling technologies. Olayinka [2020] notes that the pandemic has broadly accelerated the adoption of e-business platforms and processes across sectors.

Marinov and Marinova [2021] situate this within a wider trend of pandemic-driven corporate transformation, arguing that firms are increasingly motivated to adopt digital technology to sustain competitiveness. The scale of the projected economic effect is considerable: McKinsey estimates that artificial intelligence alone could contribute in the order of $15.7 trillion to global GDP by 2030 [Lund et al. 2020], alongside associated investment needs in infrastructure, regulation, and education and training.

These prospective gains are tempered by the sustainability and governance dimension increasingly emphasised in this literature. As logistics providers scale their use of AI, blockchain, and IoT, calls for accountability, transparency, and ethical frameworks around their deployment have grown correspondingly (see Table 2). Firms that treat these considerations as secondary to technological capability are more exposed to reputational and regulatory disruption of the kind the pandemic itself illustrated.

A further, more recent strand of scholarship pushes the resilience concept further still. Nikookar, Stevenson and Varsei [2024] propose that firms should aim not merely for resilience, understood as a return to pre-disruption performance, but for 'antifragility': the capacity to emerge from disruption structurally stronger than before. Operationalising this distinction requires evidence of post-disruption performance relative to a pre-disruption baseline, specifically, whether a firm's capacity, market position, or efficiency measurably exceeds its prior level rather than merely recovering to it. On that definition, whether DHL's digital investments have produced antifragility, as opposed to a simple return to baseline, is not something the secondary and corporate-reported sources reviewed here can establish, since none report the pre- and post-disruption comparison the concept requires. This is flagged as a specific, testable direction for the primary research called for in the concluding section, rather than treated as a claim this paper makes about DHL.

Table 2. Comparative outlook on transformation and projected future impact

Focus Area	United Kingdom	United States
Economic growth potential	Innovation-driven entrepreneurship and R&D investment.	Infrastructure, entrepreneurial culture, and emerging-tech leadership.
Sustainability and ethics	Emphasis on responsible technology use for inclusive progress.	Calls for accountability and transparency in new-technology governance.
Projected future impact	Anticipated technology-driven job creation and market diversification.	AI alone projected to contribute substantially to global GDP by 2030 [Lund et al. 2020].

CONCLUSION

This paper has examined how AI, blockchain, and IoT have supported pandemic resilience in global logistics, using DHL's UK and US operations as an illustrative comparative case. The evidence reviewed suggests these technologies contribute meaningfully to supply chain visibility, predictive capability, and transactional trust, but that their benefits are conditioned by implementation cost, legacy-system compatibility, and cybersecurity risk. The UK and US cases show convergence in the technologies adopted but divergence in what is driving that adoption: Brexit-related uncertainty in the UK's case, and competition for technology leadership alongside workforce skills gaps in the US's. The broader implication is that digital investment is a necessary but insufficient condition for resilience: it must be paired with organisational leadership, workforce development, and sustained attention to risk management.

This analysis has clear limitations. It relies substantially on secondary and corporate-reported sources rather than independent primary data, which constrains the extent to which DHL's stated outcomes can be independently verified; one specific instance of this, a set of firm-level technology-adoption statistics that could not be traced to a verifiable source, was identified and removed during revision rather than retained. The case-study design,

focused on a single, albeit major, logistics provider, also limits generalisability to the sector as a whole. Future research could usefully extend this analysis through primary data collection, such as interviews or surveys with logistics practitioners, and by examining specific operational contexts such as last-mile delivery or supply-chain-risk management in greater depth. Further work might also usefully examine the social and environmental consequences of large-scale logistics digitalisation, an area only lightly touched on here, and could operationalise the antifragility concept directly by comparing DHL's post-disruption performance metrics against a documented pre-disruption baseline.

REFERENCES

1. Accenture, 2026, Turning the supply chain talent shortage into strength, Accenture Research, 14 May. https://www.accenture.com/en/insights/supply-chain/talent-supply-chain
2. Baryannis G., Validi S., Dani S., Antoniou G., 2019, Supply chain risk management and artificial intelligence: state of the art and future research directions, International Journal of Production Research, 57(7), 2179-2202. https://doi.org/10.1080/00207543.2018.1530476
3. CSCMP, 2021, State of Logistics Report (R) 2021, Council of Supply Chain Management Professionals. Available: https://cscmp.org/CSCMP/Develop/Research/State_of_Logistics_Report.aspx
4. DHL, 2021, Revisiting Pandemic Resilience. Available: https://www.dhl.com/content/dam/dhl/global/delivered/documents/pdf/revisiting-pandemic-resilience-white-paper.pdf
5. Edger C., 2021, Outstanding operations directors: 31 case studies showcasing excellence, Authors Online, London.
6. Estolatan E., Geuna A., Guerzoni M., Nuccio M., 2018, Mapping the evolution of the robotics industry: a cross country comparison, LEI & BRICK Working Paper Series, No. 12, University of Turin, Torino.
7. Hollnagel E., Woods D.D., Leveson N., 2006, Resilience engineering: Concepts and precepts, Ashgate, Aldershot.
8. Ivanov D., 2021, Supply chain viability and the COVID-19 pandemic: a conceptual and formal generalisation of four major adaptation strategies, International Journal of Production Research, 59(12), 3535-3552. https://doi.org/10.1080/00207543.2021.1890852
9. Ivanov D., Dolgui A., 2020, Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak, International Journal of Production Research, 58(10), 2904-2915. https://doi.org/10.1080/00207543.2020.1750727
10. Lund S., Manyika J., Woetzel J., Barriball E., Krishnan M., Alicke K., Birshan M., George K., Smit S., Swan D., Hutzler K., 2020, Risk, resilience, and rebalancing in global value chains, McKinsey & Company. Available: https://www.mckinsey.com/capabilities/operations/our-insights/risk-resilience-and-rebalancing-in-global-value-chains (Accessed: 24 September 2026)
11. Manners-Bell J., 2023, Supply chain risk management: How to design and manage resilient supply chains, 4th ed., Kogan Page, London.
12. Marinov M.A., Marinova S.T. (eds.), 2021, Covid-19 and international business: change of era, Routledge, Abingdon. https://doi.org/10.4324/9781003108924
13. Nikookar E., Stevenson M., Varsei M., 2024, Building an antifragile supply chain: A capability blueprint for resilience and post-disruption growth, Journal of Supply Chain Management, 60(1), 13-31. https://doi.org/10.1111/jscm.12313
14. Olayinka O., 2020, The adoption of e-business technologies and processes in Nigerian small business enterprises, PhD thesis, University of Gloucestershire. https://doi.org/10.46289/BUSE2048
15. Queiroz M.M., Ivanov D., Dolgui A., Fosso Wamba S., 2022, Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review, Annals of Operations Research, 319(1), 1159-1196. https://doi.org/10.1007/s10479-020-03685-7
16. Raassens N., Haans H., Mullick S., 2022, Surviving the hectic early phase of the COVID-19 pandemic: A qualitative study of the supply chain strategies of food service firms in times of a crisis, The International Journal of Logistics Management, 33(3), 877-900. https://doi.org/10.1108/IJLM-01-2021-0013

17. Rebelo R.M.L., Pereira S.C.F., Queiroz M.M., 2022, The interplay between the Internet of things and supply chain management: challenges and opportunities based on a systematic literature review, Benchmarking: An International Journal, 29(2), 683-711. https://doi.org/10.1108/BIJ-02-2021-0085
18. Rees G., Mullins L.J., 2023, Management and organisational behaviour, 13th ed., Pearson, Harlow.
19. Rushton A., Croucher P., Baker P., 2022, The handbook of logistics and distribution management: Understanding the supply chain, 7th ed., Kogan Page, London.
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. Sloman J., Garratt D., Guest J., 2021, Economics, 11th ed., Pearson, Harlow.
22. UNCTAD, 2021, Digital economy report 2021: cross-border data flows and development: for whom the data flow, United Nations Conference on Trade and Development, Geneva. Available: https://unctad.org/publication/digital-economy-report-2021 (Accessed: 24 September 2026)
23. Vrontis D., Weber Y., Tsoukatos E., Maizza A., 2022, Managing innovation and digital transformation: Global issues and strategies, Emerald Publishing, Bingley.
24. WTO, 2023, World Trade Statistical Review 2023, World Trade Organization, Geneva.