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Integrating Agility, Digital Intelligence, and Sustainable Urban Logistics: A Comprehensive Framework for Resilient Modern Supply Chains

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ABSTRACT

Background: Modern supply chains operate within an environment characterized by volatility, complexity, and rapid technological change. Building supply chains that are simultaneously agile, resilient, and digitally intelligent has become an imperative across industries ranging from air cargo operations to last-mile urban deliveries (Christopher, 2000; Bombelli & Fazi, 2022). The literature contains rich but fragmented contributions on discrete elements — agility taxonomies, digital enablement, sustainable modal shifts, and empirical datasets for automation — yet a unified theoretical and operational framework that ties these elements into implementable pathways is lacking (Christopher, 2000; Costantino et al., 2012; Bamakan et al., 2021).

Methods: This paper synthesizes heterogeneous sources spanning empirical case studies, methodological contributions to agile development, technological frameworks integrating blockchain-IoT-big data, and context-specific innovations such as cargo bicycles and perpetual motion electric trucks. Using a rigorous integrative literature synthesis approach — combining conceptual mapping, comparative analysis of empirical case studies, and cross-domain theoretical elaboration — the study derives a multi-layered framework aligning strategy, operations, and digital infrastructure to support sustainable, resilient, and agile supply chains (Christopher, 2000; Bamakan et al., 2021; Gonzalez-Calderon et al., 2022).

Results: The resulting framework delineates (1) strategic principles for agility and Triple-A alignment (agility, adaptability, alignment), (2) operational modules for warehousing and last-mile logistics that embed human-in-the-loop and automated capabilities, (3) a digital intelligence stack comprising sensing, secure data fabric (blockchain), analytics, and decision automation, and (4) sustainability vectors that reconcile carbon reduction with service-level objectives through modal innovations and energy-efficient vehicle technologies (de Boer, 2018; Bamakan et al., 2021; Hunt et al., 2023; Gonzalez-Calderon et al., 2022). The framework further articulates measurement constructs and key performance indicators that balance responsiveness, cost, and environmental impact (Costantino et al., 2012; Balaji et al., 2015).

Conclusions: Integrating agility and digital intelligence provides robust pathways to resilient, low-carbon supply chains. Operationalizing this integration requires deliberate investments in data interoperability, human-centered automation in warehousing, and policy-aligned adoption of sustainable transport modes. The paper concludes with prioritized research agendas and practical implementation guidelines for managers and policymakers to accelerate transition toward agile, digitally-enabled, and sustainable supply networks (Christopher et al., 2006; Bamakan et al., 2021; Chowdhury, 2025).

Keywords

Agile supply chain; digital intelligence; resilience; sustainable logistics; last-mile delivery; warehousing; blockchain-IoT

INTRODUCTION

The dynamics of global and urban supply chains have shifted decisively over the past quarter century. Markets have become increasingly volatile and customer expectations have evolved toward immediacy, personalization, and sustainability (Christopher, 2000). This shift has placed agility at the core of competitive supply chain strategy: the capacity to sense, respond, and reconfigure operations rapidly and efficiently (Christopher, 2000; Christopher et al., 2006). Simultaneously, digital technologies — from pervasive sensing to distributed ledgers and analytics — offer unprecedented opportunities to make supply chains more visible, intelligent, and automated (Brin, 2013; Bamakan et al., 2021). However, translating technological promise into operational reality is non-trivial: it requires coherent alignment across strategy, process, organizational capability, and regulatory contexts (Costantino et al., 2012; Balaji et al., 2015).

The extant literature covers critical building blocks. Foundational conceptualizations of the agile supply chain provided by Christopher (2000) offer strategic design principles for competing in volatile markets. Costantino et al. (2012) and Balaji et al. (2015) operationalize agility within manufacturing and supply contexts. Recent advances examine the role of digital integration — blockchain coupled with IoT and big data — to establish trustworthy, high-fidelity data ecosystems that enhance performance measurement and decision-making (Bamakan et al., 2021). Empirical and case-driven work expands the horizon: Bombelli and Fazi (2022) explore the capacitated pickup and delivery problem in air cargo, highlighting collaborative constraints in intermodal contexts; Gonzalez-Calderon et al. (2022) show how cargo bicycles can materially alter last-mile sustainability trade-offs in urban settings; Hunt et al. (2023) propose radical energy rethinking with zero-fuel-cost electric truck concepts. Datasets and empirical tools such as the 6D-ViCuT visual cuboid tracking dataset (Camacho-Muñoz et al., 2023) provide enablers for human-robot collaboration in packing and warehousing processes. Collectively, these contributions indicate a rapidly evolving ecosystem where strategic agility, digital intelligence, and sustainability interact in complex ways.

Despite this progress, there are persistent gaps. The literature is fragmented across silos: theoretical agility frameworks seldom operationalize the interplay with digital technologies; digital integration studies frequently emphasize narrow technical architectures without integrating human-centered requirements; sustainability-oriented innovations are often analyzed in isolation from agility and digital resilience concerns (Christopher, 2000; Bamakan et al., 2021; Gonzalez-Calderon et al., 2022). This fragmentation constrains the ability of practitioners and policymakers to design coherent pathways that are both high-performing and sustainable. Furthermore, empirical evidence that rigorously connects interventions (e.g., blockchain implementation, cargo bicycle adoption, advanced warehousing automation) to multi-dimensional performance outcomes (responsiveness, cost, sustainability) under realistic operational constraints remains sparse (Bombelli & Fazi, 2022; Camacho-Muñoz et al., 2023).

This paper responds to these gaps by developing an integrative conceptual and operational framework that unites agility, digital intelligence, and sustainability within supply chain design and execution. The framework is grounded in the referenced literature and structured to support practical adoption by managers and iterative research by academics. The methodological approach synthesizes cross-domain evidence, identifies operational modules, and formulates measurement constructs to guide implementation and evaluation. The contribution is threefold: first, a theoretically coherent framework mapping strategic principles to operational and technical modules; second, a rich elaboration of practical pathways for implementation, including technology adoption, human-centered warehousing, and sustainable modal shifts; third, an agenda for future research that targets measurable knowledge gaps and policy levers.

METHODOLOGY

This study adopts an integrative literature synthesis approach that systematically combines conceptual, empirical, and methodological contributions from diverse research streams included in the supplied references. The methodology comprises four distinct but interrelated steps: (1) conceptual mapping, (2) comparative synthesis, (3) operational modeling (textual), and (4) framework validation through multi-source triangulation.

Conceptual mapping. The first step constructs a conceptual landscape by extracting key constructs from each reference and grouping them into thematic clusters: strategic agility and taxonomy (Christopher, 2000; Christopher et al., 2006), operational models and warehousing processes (Costantino et al., 2012; Camacho-Muñoz et al., 2023), digital intelligence and secure data architectures (Bamakan et al., 2021; Brin, 2013), and sustainable urban logistics innovations (Gonzalez-Calderon et al., 2022; Hunt et al., 2023). Each construct was dissected into subcomponents (capabilities, enablers, constraints) and relationships among constructs were annotated.

Comparative synthesis. In the second step, the study performs a comparative synthesis across the thematic clusters to identify reinforcing mechanisms and tensions. For instance, the synthesis evaluates how blockchain-IoT-big data frameworks enable transparency and trust (Bamakan et al., 2021) and how these capabilities interact with human-centric warehousing approaches evidenced by visual tracking datasets (Camacho-Muñoz et al., 2023) and collaborative operational models in air cargo (Bombelli & Fazi, 2022). The comparative synthesis places each empirical finding in the wider strategic context of agility (Christopher, 2000) and supply chain strategy taxonomies (Christopher et al., 2006).

Operational modeling (textual). The third step constructs a text-based operational model delineating modules (sensing, data fabric, analytics, execution control), process flows (order ingestion to last-mile delivery), and decision nodes (e.g., routing, capacity allocation). This model intentionally avoids mathematical formalism in favor of descriptive rigor, aligning with the requirement to explain methods through detailed narrative. Each module is mapped to evidence from the literature: for example, the sensing layer incorporates visual datasets and IoT sensing for warehousing (Camacho-Muñoz et al., 2023), while the data fabric leverages blockchain for integrity and traceability (Bamakan et al., 2021).

Framework validation through multi-source triangulation. The final step triangulates the proposed framework by cross-referencing multiple references that address similar operational phenomena from different angles. For instance, air cargo collaboration problems (Bombelli & Fazi, 2022) are compared with last-mile bicycle-led solutions (Gonzalez-Calderon et al., 2022) to validate the framework's adaptability across scales and modalities. Additionally, theoretical insights from agile product development and requirements prioritization in agile contexts (Humpert et al., 2022; Hasan et al., 2013) are used to ensure that the framework supports iterative capability development and stakeholder integration.

Throughout the methodology, claims were tied to specific references to maintain evidentiary grounding. Where interpretations extended beyond a single source, the synthesis explicitly referenced multiple supporting works (Christopher, 2000; Bamakan et al., 2021; Costantino et al., 2012). The result is a rigorously referenced, practically actionable framework grounded in the supplied literature.

RESULTS

The synthesis yields a multi-layered integrative framework comprising strategic principles, operational modules, digital infrastructure components, and sustainability pathways. The framework is presented here through detailed descriptive exposition of each element, their interconnections, and expected operational outcomes, with claims substantiated by the provided literature.

Strategic principles: agility, adaptability, alignment. Drawing on foundational work, the framework begins with three strategic principles. Agility entails rapid sensing and responsiveness to market and operational perturbations (Christopher, 2000). Adaptability emphasizes structural flexibility and the capacity to reconfigure supply chain design in response to systemic shifts (Christopher et al., 2006). Alignment refers to the strategic coherence among partners, incentives, and information-sharing mechanisms that enable coordinated responses (Costantino et al., 2012). These principles are mutually reinforcing: without alignment, agility devolves into local optimization; without adaptability, agile responses are short-lived (Christopher, 2000; Christopher et al., 2006).

Operational modules. The framework identifies five core operational modules:

1.Demand sensing and order ingestion. This module leverages real-time order streams and market indicators to update short-term forecasts and trigger operational responses. Digital visibility and event-driven architectures enable rapid translation of demand signals into operational tasks (Brin, 2013; Bamakan et al., 2021).

2.Inventory and warehousing orchestration. Warehousing is reconceptualized as an adaptive service node providing value-added functions such as dynamic slotting, cross-docking, and human-robot collaborative packing. The 6D-ViCuT dataset exemplifies how advanced visual tracking supports manual packing optimization and collaborative systems (Camacho-Muñoz et al., 2023). Agile warehousing requires flexible labor models and decision rules for prioritizing tasks, echoing agile requirements prioritization literature (Hasan et al., 2013; Balaji et al., 2015).

3.Transportation and routing control. This module accounts for multi-modal transport coordination, capacity-constrained pickup and delivery (Bombelli & Fazi, 2022), and last-mile modal selection. The model supports hybrid routing where low-emission modes (cargo bicycles) and energy-innovative vehicles (perpetual motion electric trucks) are evaluated against service and cost constraints (Gonzalez-Calderon et al., 2022; Hunt et al., 2023).

4.Data fabric and trust layer. A secure, interoperable data fabric is essential for multi-party collaboration. Blockchain-enabled architectures integrated with IoT sensors and big data analytics provide provenance, auditability, and tamper-resistance, improving trust and enabling new contractual models such as service-level smart contracts (Bamakan et al., 2021; Brin, 2013).

5.Decision support and automation. Advanced analytics, from prescriptive optimization to adaptive heuristic rules, enable automated decision-making with human oversight. The decision layer implements prioritization logic (Hasan et al., 2013) and integrates end-customer input for agile product development and customization (Humpert et al., 2022).

Digital intelligence stack. The framework translates the operational modules into a digital intelligence stack containing four layers:

1.Sensing and perception. This layer aggregates IoT telemetry, visual tracking data, and external signals (traffic, weather). Visual datasets such as 6D-ViCuT enable robust perception for manual packing and robot guidance (Camacho-Muñoz et al., 2023).

2.Secure data fabric. The fabric ensures immutable recording of critical events and enables trusted data exchange among air cargo handlers, warehousing operators, and last-mile carriers (Bamakan et al., 2021;

Bombelli & Fazi, 2022).

3.Analytics and decision models. This layer hosts forecasting, routing, and resource allocation models that are both real-time and explainable to human operators. The analytics layer also supports scenario simulations for strategic planning, consistent with Triple-A approaches (de Boer, 2018).

4.Execution and human-machine interaction. Execution interfaces translate analytics outputs to operators and autonomous systems, embedding manual overrides and iterative feedback consistent with agile development methods (Humpert et al., 2022; Hasan et al., 2013).

Sustainability vectors and modal innovations. The framework embeds sustainability as a core design constraint rather than an add-on. Two empirical pathways are emphasized. First, urban modal transformation via cargo bicycles offers measurable carbon reductions and enhanced accessibility in congested urban cores; case evidence from Medellín demonstrates operational feasibility and social benefits (Gonzalez-Calderon et al., 2022). Second, vehicle energy innovation, exemplified by perpetual motion electric truck concepts, challenges conventional fuel-cost paradigms and offers long-term decarbonization potential when integrated with renewable energy systems and storage (Hunt et al., 2023). The framework supports hybrid modal selection algorithms that weigh emissions, delivery time, and cost, enabling managers to operationalize sustainability trade-offs.

Measurement constructs and KPIs. The framework proposes a balanced measurement set that combines responsiveness (order lead-time, fill rate), cost-efficiency (total logistics cost, cost-per-delivery), and environmental impact (CO_2-equivalent per delivery, energy intensity). Importantly, trust and data integrity metrics (data provenance score, auditability latency) are included to reflect the centrality of the secure data fabric (Bamakan et al., 2021; Brin, 2013). The KPI set supports continuous improvement by aligning with agile development practices for prioritization and iteration (Hasan et al., 2013; Balaji et al., 2015).

Cross-context validation. Triangulation across air cargo (Bombelli & Fazi, 2022), warehousing visual tracking (Camacho-Muñoz et al., 2023), and urban last-mile innovations (Gonzalez-Calderon et al., 2022; Hunt et al., 2023) confirms the framework's cross-scale applicability. For example, capacity-constrained pickup and delivery models in air cargo resonate with last-mile capacity limitations in urban logistics, suggesting that modular digital intelligence architectures can be scaled and configured to local constraints (Bombelli & Fazi, 2022; Gonzalez-Calderon et al., 2022).

DISCUSSION

The integrative framework described above provides theoretically grounded and operationally tangible pathways to design supply chains that are agile, digitally intelligent, and sustainable. The following discussion unpacks the theoretical implications, practical trade-offs, limitations of the present synthesis, and a prioritized future research agenda.

Theoretical implications. First, the framework enriches classical agility theory by explicitly integrating digital trust infrastructures and sustainability constraints into the strategic core. Traditional agility models emphasized responsiveness and flexibility (Christopher, 2000), but typically regarded information flows and partner alignment as enablers rather than intrinsic strategic elements. By making secure data fabrics and human-machine interaction central pillars, the framework reframes agility as socio-technical — reliant on both organizational arrangements and digital architectures (Bamakan et al., 2021).

Second, the framework suggests a layered modularity where operational agility is achieved through composable modules (sensing, data fabric, analytics, execution). This modularity aligns with supply chain taxonomy work that advocates for selection of strategies based on product and market characteristics (Christopher et al., 2006), while offering an extensible architecture for integrating new technological components (e.g., advanced perception datasets, or blockchain smart contracts).

Third, by embedding sustainability as a constraining objective rather than a separate optimization goal, the framework encourages multi-criteria decision-making that aligns short-term service imperatives with long-term environmental commitments. This reframing helps reconcile the common tension between speed (express deliveries) and emission reduction by enabling context-aware modal selection and capacity planning (Gonzalez-Calderon et al., 2022; Hunt et al., 2023).

Practical implications and trade-offs. Operationalizing the framework involves several practical decisions and trade-offs. Data integration and trust. Implementing a blockchain-enabled data fabric requires investment and governance alignment among partners. While the fabric increases trust and auditability (Bamakan et al., 2021), it also introduces administrative and technical complexity, such as consensus mechanisms, data privacy concerns, and throughput constraints. Managers must weigh the benefits of tamper-resistant records against latency and cost.

Human-machine collaboration in warehousing. Visual tracking datasets and human-in-the-loop systems (Camacho-Muñoz et al., 2023) promise efficiency gains but require careful design of interfaces and labor policies. Agile work allocation and task prioritization (Hasan et al., 2013; Balaji et al., 2015) can mitigate worker displacement risks but demand investment in training and participatory design.

Sustainability vs. service-level trade-offs. Selecting low-emission modes like cargo bicycles in congested urban cores improves sustainability but can influence capacity and delivery time. The framework's hybrid routing algorithms allow for dynamic trade-off calibration, but policy and customer expectations also influence choices. For example, regulatory incentives for zero-emission vehicles can shift optimal decisions (de Boer, 2018; Gonzalez-Calderon et al., 2022).

Limitations of the synthesis. The paper's integrative approach necessarily synthesizes heterogeneous evidence but does not present novel primary empirical data. The conclusions are therefore contingent on the validity and contextual generalizability of the referenced studies. Several specific limitations are worth noting.

Scope of references. The analysis is constrained to the provided references and thus might not capture the full breadth of emergent technologies or the latest empirical evidence beyond these works. The included sources, however, represent a diverse cross-section of theory, case evidence, and methodological innovation (Christopher, 2000; Bamakan et al., 2021; Camacho-Muñoz et al., 2023).

Quantitative validation. The framework proposes measurement constructs and operational modules, but empirical validation with multi-enterprise datasets and controlled field experiments remains to be completed. For instance, while cargo bicycle adoption shows positive signs in Medellín (Gonzalez-Calderon et al., 2022), broader urban generalizability requires further trials across different city geometries and demand patterns.

Technological maturity and adoption barriers. Certain technological proposals, such as perpetual motion electric truck concepts (Hunt et al., 2023), are visionary and require extensive engineering validation and regulatory acceptance. Similarly, blockchain deployment at scale raises governance and interoperability challenges (Bamakan et al., 2021). Early adopters must prepare for iterative development and potential initial performance trade-offs.

Future research agenda. To advance the integrative framework into validated practice, the following research priorities are recommended, each tied to specific literature-derived gaps.

Empirical field trials of the integrated framework. Multi-stakeholder pilot projects that implement the full stack — sensing, blockchain data fabric, analytics, and sustainable modal options — are critical. Pilots should measure the proposed KPIs to quantify trade-offs and iterate designs (Bombelli & Fazi, 2022; Bamakan et al., 2021).

Human-machine systems research. Investigate the ergonomics, labor dynamics, and interface design required to integrate visual perception datasets (Camacho-Muñoz et al., 2023) into daily warehousing operations without degrading worker well-being. Research should combine qualitative ethnography with quantitative productivity measures.

Governance models for secure data fabrics. Comparative studies of governance structures (consortium chains, federated models, permissioned ledgers) are needed to identify models that provide trust without excessive latency or control concentration (Bamakan et al., 2021).

Policy and incentive design for sustainable modal shifts. Research should explore how regulatory incentives, urban planning, and public procurement can accelerate adoption of cargo bicycles and electric vehicle innovations, informed by case evidence from Medellín and energy-innovative vehicle proposals (Gonzalez-Calderon et al., 2022; Hunt et al., 2023).

Methodological advances for multi-criteria optimization under uncertainty. Develop and test models that incorporate probabilistic demand, capacity constraints, and emissions accounting into decision-making heuristics suitable for near-real-time operations (Bombelli & Fazi, 2022; Costantino et al., 2012).

Managerial guidelines and capability building. Actionable toolkits and training programs for managers to implement the framework's principles should be developed, aligning with agile development practices for prioritizing investments and requirements (Hasan et al., 2013; Humpert et al., 2022).

Implementation roadmap and actionable steps. For practitioners seeking to pilot the framework, the following pragmatic roadmap synthesizes the literature into staged actions:

1.Diagnose current state and priorities. Use the KPI set to baseline responsiveness, cost, and emissions (Costantino et al., 2012; Balaji et al., 2015).

2.Build minimum viable digital fabric. Start with interoperable data standards and a permissioned ledger pilot for critical event logging among primary partners (Bamakan et al., 2021).

3.Pilot human-in-the-loop warehousing improvements. Deploy visual tracking tools in selected fulfilment centers to streamline packing and reduce errors (Camacho-Muñoz et al., 2023).

4.Test modal innovations in constrained geographies. Implement cargo bicycle last-mile pilots in congested urban zones while measuring service and emissions impacts (Gonzalez-Calderon et al., 2022).

5.Scale analytics and decision automation. Gradually automate routine decisions while maintaining human oversight, following agile prioritization of features (Hasan et al., 2013; Humpert et al., 2022).

6.Embed continuous improvement. Apply agile retrospectives and iterative improvement cycles to refine governance, interfaces, and algorithms (Balaji et al., 2015).

By following this staged approach, organizations can balance risk, investment, and learning while moving toward the integrated vision outlined in the framework.

CONCLUSION

The contemporary imperative for supply chains is to be simultaneously agile, resilient, and sustainable in an increasingly digitized and uncertain operating environment. This paper presents a comprehensive integrative framework that ties strategic agility principles to operational modules and a layered digital intelligence architecture while embedding sustainability as a core constraint. Drawing on a diverse set of literature — from foundational agile supply chain theory to cutting-edge datasets for warehouse perception and visionary vehicle concepts — the framework offers both theoretical enrichment and operational pathways.

Practical implementation requires careful attention to governance, human-centered design, and staged investments in digital infrastructure. While blockchain-IoT-big data architectures provide powerful enablers for trust and visibility (Bamakan et al., 2021), human-machine collaboration in warehousing (Camacho-Muñoz et al., 2023) and sustainable last-mile modal innovations (Gonzalez-Calderon et al., 2022; Hunt et al., 2023) are equally critical. The proposed measurement constructs and roadmap provide a starting point for managers and policymakers to prioritize interventions and measure outcomes.

Limitations of this synthesis include its reliance on the provided literature and the absence of primary empirical validation of the full integrated stack. The future research agenda recommends empirical pilots, governance experiments, and human-centered studies to validate and refine the framework. Ultimately, the path to resilient, low-carbon, and agile supply chains will be iterative, requiring multi-stakeholder collaboration, policy alignment, and sustained capability building. The conceptual and practical pathways advanced here aim to accelerate that transition and provide a basis for rigorous empirical testing and progressive implementation.

REFERENCES

1. Bombelli, A., & Fazi, S. (2022). The ground handler dock capacitated pickup and delivery problem with time windows: A collaborative framework for air cargo operations. Transportation Research Part E: Logistics and Transportation Review, 159. https://doi.org/10.1016/j.tre.2022.102603
2. Camacho-Muñoz, G. A., Franco, J. C. M., Nope-Rodríguez, S. E., Loaiza-Correa, H., Gil-Parga, S., & Álvarez-Martínez, D. (2023). 6D-ViCuT: Six degree-of-freedom visual cuboid tracking dataset for manual packing of cargo in warehouses. Data in Brief, 49. https://doi.org/10.1016/j.dib.2023.109385
3. Gonzalez-Calderon, C. A., Posada-Henao, J. J., Granada-Muñoz, C. A., Moreno-Palacio, D. P., & Arcila-Mena, G. (2022). Cargo bicycles as an alternative to make sustainable last-mile deliveries in Medellin, Colombia. Case Studies on Transport Policy, 10(2), 1172–1187. https://doi.org/10.1016/j.cstp.2022.04.006
4. Hasan, R., Ta, A.-, & Razali, R. (2013). Prioritizing Requirements in Agile Development : A Conceptual Framework. Procedia Technology, 11(Iceei), 733–739. https://doi.org/10.1016/j.protcy.2013.12.252
5. Humpert, L., Röhm, B., Anacker, H., Dumitrescu, R., & Anderl, R. (2022). Method for direct end customer integration into the agile product development. Procedia CIRP, 109, 215–220. https://doi.org/10.1016/j.procir.2022.05.239
6. Hunt, J. D., Nascimento, A., Tong, W., Zakeri, B., Jurasz, J., Patro, E. R., Đurin, B., de Jesus Pacheco, D. A., de Freitas, M. A. V., Filho, W. L., & Wada, Y. (2023). Perpetual motion electric truck, transporting cargo with zero fuel costs. Journal of Energy Storage, 72. https://doi.org/10.1016/j.est.2023.108671
7. Balaji, M., Velmurugan, V., & Subashree, C. (2015). OriginalTADS: An assessment methodology for agile supply chains. Journal of Applied Research and Technology, 13, 504-509.

https://doi.org/10.1016/j.jart.2015.10.002

8. Bamakan, S. M. H., Faregh, N., & ZareRavasan, A. (2021). Di-ANFIS: An integrated blockchain-IoT-big dataenabled framework for evaluating service supply chain performance. Journal of Computational Design and Engineering, 8(2), 676-690. https://doi.org/10.1093/jcde/qwab007

9. Ben Ruben, R., Prasanth, A. S., Ramesh, R., & Narendran, S. A. P. (2013, February). Implementation study on apply agile supply chain paradigm in the manufacturing of a conventional automobile horn in an Indian company. International Journal of Materials, Mechanics, and Manufacturing, 1(1), 97-101. https://doi.org/10.7763/IJMMM.2013.V1.21

10. Chowdhury, W. A. (2025). Agile, IoT, and AI: Revolutionizing Warehouse Tracking and Inventory Management in Supply Chain Operations. Journal of Procurement and Supply Chain Management, 4(1), 41–47. https://doi.org/10.58425/jpscm.v4i1.349

11. Berger, P. (2022, November 29). Amazon launches supply-chain software service. The Wall Street Journal. Dow Jones Institutional News. https://usf-flvc.primo.exlibrisgroup.com/permalink/01FALSC_USF/un0hgn/cdi_proquest_wirefeeds_2741162830

12. Brin, D. W. (2013, February 12). Companies make supply chains more agile with better visibility. MHI.org. https://www.mhi.org/media/news/12203

13. Christopher, M. (2000, January). The agile supply chain: Competing in volatile markets. Industrial Marketing Management, 29(1), 37-44. https://doi.org/10.1016/S0019-8501(99)00110-8

14. Christopher, M., Peck, H., & Towill, D. (2006). A taxonomy for selecting global supply chain strategies. The International Journal of Logistics Management, 17(2), 277-287. https://doi.org/10.1108/09574090610689998

15. Costantino, N., Dotoli, M., Falagario, M., Fanti, M. P., & Mangini, A. M. (2012). A model for supply management of agile manufacturing supply chains. International Journal of Production Economics, 135(1), 451-457. https://doi.org/10.1016/j.ijpe.2011.08.021

16. de Boer, T. (2018, September 3). Building a Triple A supply chain: Ten tactics that work [Web log]. https://www.tradecloud1.com/en/building-a-triple-a-supply-chain-ten-tactics-that-work/

17. Deconinck, K., Avery, E., & Jackson, L. A. (2020). Food supply chains and Covid-19: Impacts and policy lessons. EuroChoices, 19(3), 34–39. https://doi.org/10.1111/1746-692X.12297