

NAVIGATING DIGITALIZATION IN BUSINESS LOGISTICS: EMERGING TECHNOLOGIES AND SUPPLY CHAIN TRANSFORMATION

Megha Sunil NAIR, Vytautas Magnus University, Agriculture Academy, Faculty of Bioeconomy Development,
email: Megha.sunil.nair@vdu.lt

Abstract

Digitalisation is defined as one of the key elements driving platforms transformation on modern business logistics that can optimise operational efficiency and supply chain visibility in order to build value-added decision making processes. The rapid development of digital technologies including Artificial Intelligence (AI), the Internet of Things (IoT), blockchain and big data analytics brings about the transformation of traditional logistics systems leading to more responsive and data driven supply chain networks. In this article, we investigate the impact of digitalisation in business logistics and wonder how new technologies allow optimisation of logistics. The research is thus derived based on the review of recent scientific literature and secondary data sources focusing on digital supply chain management or logistics innovation. This helps us to conclude that the logistics performance is greatly improved through digital technologies which provides real-time tracking, predictive analytics, advanced inventory management and enhanced collaboration between the supply chain stakeholders. On the other hand, there are lots of difficulties of implementing digital operations like high budgeted implementations, cyber security vulnerabilities, technology integration problems and skilled human resource shortage. According to the study, businesses that manage their digitalisation in logistics successfully do this thanks to strategic investment in digital infrastructure, organisational readiness and innovation. The results give valuable insights on the opportunities and challenges of digital transformation for logistics, bringing to light the importance of technology-enabled logistics systems in gaining a competitive edge in the business landscape today.

Keywords: digitalization, business logistics, supply chain management, industry 4.0, logistics optimization.

Introduction

Digital technologies have evolved rapidly and affected the world of logistics in modern business. The global supply chain has gotten more complicated as both international trade expanded and e-commerce increased demand for faster and more reliable delivery systems. In order to address these challenges, organisations are turning to digital technology to improve logistics performance, provide operational visibility and coordinate across supply chains. Artificial intelligence, big data analytics, blockchain and the Internet of Things are just some technologies powering logistics automation to transition from a manual process to an intelligent automated process (Holloway, 2024). Technological innovations are contributing towards organisation's betterment with respect to demand planning, real-time shipment tracking and inventory management which allows organisations to increase efficiency across their supply chain (Ivanov et al., 2021). The digitalisation also brings opportunities to improve the transparency and decision-making in logistics networks. Logistics Service Providers (4PLs) who integrate digital data through the value chain will be able to have better visibility of their transportation activities, warehousing operations and distribution processes. With an integration of digital technologies, organisations are capable of sifting through large amounts of both operational data and identify inefficiencies across their supply chain. Digital transformation should be a strategic priority today to help companies stay relevant in the evolving global supply chain (Huang et al., 2023).

Despite many benefits of digital logistics systems, organisations also encounter various challenges to implement digital transformation initiatives. Challenges such as high investment costs in technology, cybersecurity risks, lack of digital skills among employees and weak integration of new technologies with existing logistics infrastructure can be hurdles for promoting the adoption process. Moreover, when implementing digital logistics solutions, most companies face the challenge of balancing technological innovation with operational stability. Such challenges all point to the pressing need for systematic research investigation into how organizations successfully deal with digitalisation in business logistics (Dolgui, Ivanov, 2021).

Research aim: To analyse the role of digital technologies in transforming business logistics and improving supply chain efficiency.

The following **objectives** have been set to achieve the aim:

1. To examine the key digital technologies applied in business logistics.
2. To evaluate the impact of digitalisation on logistics performance and supply chain management.
3. To identify the challenges associated with the implementation of digital logistics systems.

Research object and methods

The research object of this study is the digitisation process in business logistics and its implication on supply chain efficiency, operational performance, and logistics management practices. Digital technologies such as artificial

intelligence, big data analytics blockchain and Internet of Things have made the logistics systems transform in an interval of days. These technologies are helping organisations to share information, automate processes for operations, and increase decision making in logistics networks. Consequently, digital logistics has been recognised as an indispensable element in current supply chain management approaches aimed at increasing the transparency, flexibility and responsiveness of the world's logistics systems. The methodology for the purpose of this investigation is based on the typical approach of reviewing and analyzing the scientific literature in terms of recent science publications on the digital transformation of logistics and supply chain management. The study reviewed literature produced in the past few years - academic articles, industry reports and scholarly publications - to find the primary trends, technology developments and strategic implications related to digital logistics systems. Such an approach enables the investigation to consolidate the existing knowledge, and presentation of comprehensive understanding of how the digital technologies are reshaping the logistics operations and impacting organisational performance.

The difference is that a comparative analytical study is employed alongside the literature analysis in order to evaluate the impact of different types of digital technology in relation to various aspects of logistics. The research juxtaposes results gained in a number of studies and identifies general trends, potentials and issues concerning introduction of digital logistics systems. This analytical approach contributes to identify the technological innovations that bring more impact on the efficiency of the logistics, as well as the integration of a supply chain. Moreover, the paper involves secondary data analysis strategy to examine the nature in which digital technologies are being incorporated in the modern logistics environment. The recent years the use of digital tools in logistics management reflected in the secondary data of scientific article and industry studies. Also, these sources of data provide an opportunity to concentrate the research on cutting edge trends such as smart logistics platforms, digital supply chain networks and automated logistics operations that will be dominant in configuring global logistics systems..

Research results and discussion

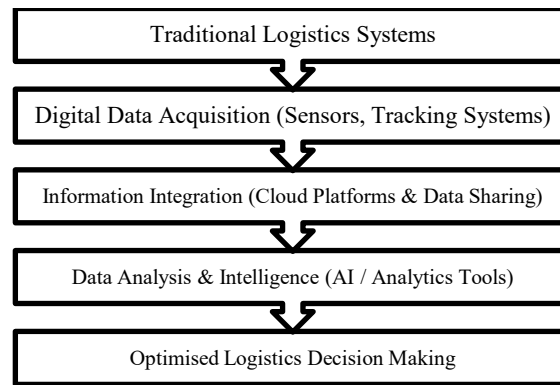
Integration of Digital Technologies in the Modern Logistics Systems

The sophisticated digital technologies have been introduced in the logistics operations as the multi-dimensional global supply chains become more complex. Logistics systems are getting integrated and dynamic to the changes in the market because of digital transformation. Cloud computing, data analytics platforms and intelligent logistics software enable companies to more effectively manage their transportation network, warehouse operations and inventory systems. This will make it possible for firms to assure the higher operational visibility and coordination of systems through the different stakeholders in the supply chain by digitising logistics systems (Oyewole et al., 2024). Another critical dimension of the digital integration of the logistics are the use of systems of information in real time. Digital platforms that provide information at the moment: They support logistics managers to maintain the movement of shipments, and monitor the performance of the delivery and quickly act when their operations are disrupted. Such technologies are helping organisations to determine efficiency in supply chain networks and fix up them faster. Consequently, it is possible for logistics firms to enhance dependability of service rendered and strengthen resilience of supply chain in such competitive business landscape (Zhen, Li, 2022). With improved sharing of data, digital platforms equate to new collaboration opportunities between supply chain partners. Integrated logistics information systems mean integration of suppliers, transport providers, warehouse operators and retailers into a single digital world. Connectedness helps organisations coordinate its logistics activities to minimise delays which happen due to mismatched information. Improved digital collaboration to effective resources allocation and logistics performance improvement (Helo, Hao, 2024).

Moreover, because of digital logistics platforms, it has become easier to implement intelligent logistics planning systems. These systems make use of machine learning algorithms and optimisation models to enhance scheduling of transportation, route planning and inventory allocation. Through the analysis of operational data, these digital logistics platforms can recommend more efficient configuration of logistic activities which fragment transportation and delivery processes across supply chains which reduce transport costs and improve delivery efficiency (Implementing the Digital Supply Chain Transformation, 2021).

Operational Improvements Facilitated with Digital Logistics Solutions

Automation and intelligent decision making using digital technologies are becoming the biggest leverage to make logistics more efficient. Automation of logistics processes reduces the need for manual intervention, requiring improved accuracy of operations, in terms of the order processing, shipment scheduling and inventory management. Logistics organisations can reduce operational errors to a huge extent and help to speed up logistics operations through digital automation (Junge, Straube, 2020). Another critical operation improvement made possible through digitalisation is the improvement of predictive logistics management. Predictive analytics tools help organizations to analyze the past data related to logistics and predict the future demand patterns, transportation needs, and inventory requirements. Specific to supply chain, organizations can proactively manage the logistics strategy and reduce the disruption in company's functions by anticipating the variances in demand and supply (Choi et al., 2018). The digital logistics solutions allow an optimization of the warehouse management systems, in which the goods can be managed and stored more effectively. This includes the likes of automation in warehouse picking systems and intelligent inventory tracking solutions and robotics increased storage operations. Such innovations allow logistics firms to optimise the area use of their depots, they increase the order fulfilment accuracy hence reducing manual work within logistics facilities (Chen et al., 2022).



Source: adapted from Gülmez & Denktaş-Şakar (2024)

Fig 1. Digital Logistics Transformation Framework

Moreover, digitalisation helps the optimisation of transport management systems. By utilising advanced routing algorithms, and digital transport management platforms, logistics organisations are able to virtually optimise vehicle routes, reduce the consumption of fuel and enhance delivery scheduling along with a plethora of other benefits. These systems are used to analyse the traffic conditions, transportation demands and how many vehicles available in a certain area and based on that they optimise the route of delivery to increase the overall efficiency of transportation (Liu, Chiu, 2021). The other operating advantage to be found in digital logistics is that of customer service performance. Customers are given real-time information regarding shipment, delivery alerts and web-based shipment tracking facilities by digital logistics platforms. Such are the services that help improve the customer experience in terms of improvement in transparency and reliability with regards to logistics operations. The emerging of digital economy has put greater expectations upon customer and the increased attention on responsive and customer-centric logistic service has led to increased reliance on digital technologies by logistics organisations (Schilling, Seuring, 2023).

Quantitative Analysis of the Functioning of Digital Logistics

Many industries have seen a measurable improvement in supply chain performance indicators after implementing digital technologies for their supply chain operations. Organisations can use digital logistics platforms to capture the data of operations to evaluate the effectiveness of logistics activities from transportation, inventory control, orders processing and warehouse operations (Salamah et al., 2024). By taking advantage of digital tracking systems and data evaluation tools, organizations can better get an idea of performance gains and pinpoint possible areas where they may be able to increase operation efficiency. Commonly used operational and financial performance indices are: delivery time; transportation cost, the inventory turnover and the accuracy of orders to evaluate the effectiveness of digital logistics systems (Wei et al., 2024). Digital transformation also allows logistics managers to monitor trends of performances over time, able to judge impact performance from digital solutions. A practical application in this domain would be the adoption of such systems through automation technology such as real-time tracking systems and warehouse automated management so that a lot of delivery delays can be avoided, accomplish fulfilment at relatively shorter lead time involving higher accuracy rates among many logistic organisations. Analytics tools help managers get a better understanding of their patterns of operation and how to maximize their schedules and distribution strategies for transportation, warehousing, etc. These improvements result in better coordination between the partners in the supply chain and improved levels of customer satisfaction (Zaida et al., 2024).

Moreover, the performance metric analysis helps the organisations to judge the economic implication of their digital transformation investments in logistics. Developed to compare the performance of logistics performance indicators before and after digital systems have been implemented, organisations can look to find out if their digital transformation initiatives deliver tangible operational benefits. The literature has shown not only decreased costs of operations but also better resource utilisation and response to changes in market demand as reasons why companies implementing digital logistics technologies has the advantage (Sundarakani et al., 2024).

Table 1. Digital Logistics Transformation Framework

Performance Indicator	Traditional Logistics	Digital Logistics Systems
Average delivery time	5–7 days	2–4 days
Order processing accuracy	85%	96%
Inventory turnover rate	4 times/year	7 times/year
Transportation cost efficiency	Moderate	High
Real-time shipment visibility	Limited	Full tracking

Source: adapted from Zaida et al. (2024)

The data shown in Table 1 gives an idea of how the use of digital logistic technologies can dramatically improve key operational metrics in supply chain management. Digital platforms offer more visibility of information and support faster decision-making processes, which ultimately improve logistics efficiency and reliability of service. These

quantitative indicators demonstrate the strategic importance of digital transformation for organisations that want to stay competitive in today's logistics environments:

Strategic Barriers and New Opportunities for Digital Logistics

Despite the many benefits of digital logistics, organisations are faced with a number of strategic challenges when implementing digital transformation efforts. One of the biggest barriers though is the integration of the digital technologies with existing logistics infrastructure. Many logistics companies are operating with legacy information systems that are not fully compatible with modern digital platforms (Singh, 2026). There is often huge organisational restructuring and technological updates required to integrate new technologies into these systems (Albrecht et al., 2023). Another important challenge is a lack of digital skills and technological expertise in logistics organisations. The successful introduction of advanced digital logistics systems requires employees who specialize in the fields of data analytics, information technology, and digital supply chain management. However, many logistics firms find it difficult to hire and train professionals with these specialised skills, which can cause delays in the digital transformation process (Lim et al., 2018).

Cybersecurity also is becoming a more critical issue in digital logistics systems. As logistics networks are now far more dependent on interconnected digital platforms and information systems that are accessible through the cloud, they become increasingly vulnerable to cyberattacks and data breaches. Logistics organisations are thus expected to put in place strong cybersecurity systems that cushion the sensitive operational data and foster trust among the supply chain partners (Choi et al., 2023). At the same time, however, digitalisation also creates new opportunities for developing sustainable and smart logistics systems. Digital technologies are enabling organisations to optimise transport routes, energy consumption and minimise impact to the environment within the supply chain operations. By integrating digital technologies into their operations, logistics companies can streamline their processes and foster a culture of sustainability in the logistics sector (Rahimi et al., 2020). Looking on the horizon, it is likely that the future of logistics should be characterised by even more intelligent and autonomous systems. Emerging technologies such as digital twins, autonomous delivery systems, and AI-powered logistics planning tools promise to revolutionize the way in which logistics is run for the foreseeable future. These technologies will help organisations to simulate logistics scenarios, anticipate supply chain disruptions and optimise logistics strategies in real-time, which will create more resilient and adaptive supply chain systems (Zhao et al., 2023).

Conclusions

1. It cast some light on digital transformation in business logistics part and overall supply chain efficiency. The results have shown that involving advanced digital technologies in today logistics systems greatly enhanced them. Digital platforms, intelligent information systems and data-driven logistics tools enable organisations with operational visibility, optimised logistics processes and enhanced co-ordination of supply chain partners.

2. The study also found that digital technology contributes to substantial operational gains in Logistics management. This provides organisations a unique opportunity to harness the capabilities of technology, from artificial intelligence (AI) to Internet-connected monitoring systems to big data analytics for improved demand forecasting and optimisation of transportation routes towards enhanced warehouse management. These technologies promote more flexible decision making and enable organisations to react more quickly to changes in market demand and disruptions in the supply chain.

3. Although these advantages are highly short-lived, the literature indicates that digitalization in logistical systems introduces various strategic problems. These challenges such as high technological investment requirements to do with cybersecurity risks and lack of availability of qualified digital professionals can hamper successful adoption through initiatives oriented towards digital transformation. As a result, organisations need to formulate the right technological strategies and make investments towards workforce development that will assist with achieving successful digital transformation of logistics operations.

4. Digitalisation in the current environment, has emerged to be an inevitable force that too strong to not become a game changer for business logistics. Meaning, the continue development of logistics with an intelligent management system that are not only supported by digital platforms and additionally also analytics technology advance.

References

1. Holloway, S. (2024). Digital Transformation in Supply Chain Management: A Systematic Literature Review of Trends and Applications. <https://doi.org/10.20944/preprints202411.2423.v1>
2. Ivanov, D., & Dolgui, A. (2021). A digital supply chain twin for managing the disruption risks and resilience in the era of industry 4.0. *Production Planning & Control*, 32(9), 775–788. <https://doi.org/10.1080/09537287.2020.1768450>
3. Huang, K., Wang, K., Lee, P. K. C., & Yeung, A. C. L. (2023). The impact of Industry 4.0 on supply chain capability and Supply Chain Resilience: A dynamic resource-based view. *International Journal of Production Economics*, 262, 108913. <https://doi.org/10.1016/j.ijpe.2023.108913>
4. Dolgui, A., & Ivanov, D. (2021). Ripple effect and supply chain disruption management: New Trends and research directions. *International Journal of Production Research*, 59(1), 102–109. <https://doi.org/10.1080/00207543.2021.1840148> Adedoyin

5. Zhen, L., & Li, H. (2022). A literature review of Smart Warehouse Operations Management. *Frontiers of Engineering Management*, 9(1), 31–55. <https://doi.org/10.1007/s42524-021-0178-9>
6. Implementing the Digital Supply Chain Transformation. (2021). *Digital Transformation of the Supply Chain*, 55–64. https://doi.org/10.1142/9789811229602_0007
7. Junge, A. L., & Straube, F. (2020). Sustainable Supply Chains – Digital Transformation Technologies’ impact on the social and environmental dimension. *Procedia Manufacturing*, 43, 736–742. <https://doi.org/10.1016/j.promfg.2020.02.110>
8. Choi, T., Wallace, S. W., & Wang, Y. (2018). Big Data Analytics in Operations Management. *Production and Operations Management*, 27(10), 1868–1883. <https://doi.org/10.1111/poms.12838>
9. Chen, S., Meng, Q., & Choi, T.-M. (2022). Transportation Research Part E-logistics and Transportation Review: 25 years in retrospect. *Transportation Research Part E: Logistics and Transportation Review*, 161, 102709. <https://doi.org/10.1016/j.tre.2022.102709>
10. Gülmez, S., & Denktaş-Şakar, G. (2024). Digital Transformation Framework for Logistics Service Providers. *Handbook of Digital Innovation, Transformation, and Sustainable Development in a Post-Pandemic Era*, 60–77. <https://doi.org/10.1201/9781003438748-4>
11. Liu, K. P., & Chiu, W. (2021). Supply chain 4.0: The impact of Supply Chain Digitalization and integration on firm performance. *Asian Journal of Business Ethics*, 10(2), 371–389. <https://doi.org/10.1007/s13520-021-00137-8>
12. Oyewole, A. T., Okoye, C. C., Ofodile, O. C., & Ejairu, E. (2024). Reviewing predictive analytics in supply chain management: Applications and benefits. *World Journal of Advanced Research and Reviews*, 21(3), 568–574. <https://doi.org/10.30574/wjarr.2024.21.3.0673>
13. Schilling, L., & Seuring, S. (2023). Linking the digital and sustainable transformation with supply chain practices. *International Journal of Production Research*, 62(3), 949–973. <https://doi.org/10.1080/00207543.2023.2173502>
14. Salamah, E., Alzubi, A., Yinal, A. (2024). Unveiling the impact of digitalization on supply chain performance in the post-COVID-19 era. *Sustainability*, 16, 304. <https://doi.org/10.3390/su16010304>
15. Wei, S., Liu, H., Xu, W., & Chen, X. (2024). The impact of supply chain digitalization on Supply Chain Performance: A moderated mediation model. *Information Technology and Management*, 26(4), 467–481. <https://doi.org/10.1007/s10799-024-00431-4>
16. Zaid, M., Farooqi, R., & Azmi, S. N. (2025). Driving sustainable supply chain performance through digital transformation: the role of information exchange and responsiveness. *Cogent Business & Management*, 12(1), 2443047.. <https://doi.org/10.1080/23311975.2024.2443047>
17. Sundarakani, B., Manikas, I., & Gunasekaran, A. (2024). The role of digital transformation in achieving sustainable supply chain management in Industry 4.0: an editorial review perspective. *International Journal of Logistics Research and Applications*, 27(6), 843–851. <https://doi.org/10.1080/13675567.2024.2332123>
18. Zaid, M., Farooqi, R., & Azmi, S. N. (2024). Driving Sustainable Supply Chain Performance Through Digital Transformation: The role of information exchange and responsiveness. *Cogent Business & Management*, 12(1). <https://doi.org/10.1080/23311975.2024.2443047>
19. Singh, T. (2026). Digital Transformation in Operations Management and Supply Chain Management. *Digital Transformation*, 122–135. <https://doi.org/10.4324/9781003672296-11>
20. Albrecht, T., Baier, M.-S., Gimpel, H., Meierhöfer, S., Röglinger, M., Schlüchtermann, J., & Will, L. (2023). Leveraging Digital Technologies in logistics 4.0: Insights on affordances from Intralogistics Processes. *Information Systems Frontiers*, 26(2), 755–774. <https://doi.org/10.1007/s10796-023-10394-6>
21. Lim, S. F., Jin, X., & Srai, J. S. (2018). Consumer-driven e-commerce. *International Journal of Physical Distribution & Logistics Management*, 48(3), 308–332. <https://doi.org/10.1108/ijpdlm-02-2017-0081>
22. Rahimi, I., Gandomi, A. H., Ülkü, M. A., & Fong, S. J. (2020). Big Data Analytics in Supply Chain Management, 1–7. <https://doi.org/10.1201/9780367816384-1>
23. Zhao, N., Hong, J., & Lau, K. H. (2023). Impact of supply chain digitalization on Supply Chain Resilience and performance: A multi-mediation model. *International Journal of Production Economics*, 259, 108817. <https://doi.org/10.1016/j.ijpe.2023.108817>