

INNOVATION AND TECHNOLOGICAL CHANGES IN SUPPLY CHAINS

DOI: 10.5937/EMC26094S

László Szabó

Budapest University of Economics and Business, Faculty of Marketing and Business Communication,
Budapest, Hungary

E-mail: szabo.laszlo4@uni-bge.hu

ABSTRACT

The supply chains have undergone significant transformation in recent decades due to rapid technological development, digitalization, globalization, and changing customer expectations. Innovation has become a critical factor in maintaining supply chain competitiveness, resilience, and sustainability. The most important technological changes and innovations influencing modern supply chains, including automation, artificial intelligence, blockchain technology, Internet of Things (IoT), big data analytics, and sustainable logistics solutions. Technological innovation substantially improves supply chain visibility, operational efficiency, flexibility, and decision-making processes. However, implementation challenges such as high investment costs, cybersecurity risks, and workforce adaptation remain significant barriers.

Key words: Supply chain, Innovation, Digitalization, Artificial intelligence, Logistics

INTRODUCTION

The traditional supply chains focused primarily on cost reduction and operational efficiency. However, modern supply chains increasingly emphasize flexibility, resilience, digital connectivity, and sustainability. Technological innovations enable organizations to optimize transportation, inventory management, warehousing, forecasting, and customer service processes more effectively than ever before (Ivanov & Dolgui, 2020).

The COVID-19 pandemic further highlighted the importance of technological adaptation in supply chains. Companies with advanced digital capabilities were better able to manage disruptions, monitor inventory, and respond rapidly to unexpected market changes (Queiroz et al., 2020). The purpose of this paper is to identify the most significant innovations and technological changes affecting supply chains and to illustrate their impact on logistics and supply chain performance.

DIGITAL TRANSFORMATION IN SUPPLY CHAINS

Digital transformation refers to the integration of digital technologies into supply chain operations and organizational processes. It fundamentally changes how companies collect, analyze, and utilize information.

One of the most important aspects of digital transformation is real-time data availability. Modern supply chains increasingly rely on digital platforms, cloud computing, and integrated information systems to improve coordination between suppliers, manufacturers, distributors, and customers (Winkelhaus & Grosse, 2020).

The main benefits of digital transformation are generally as follows:

- greater operational transparency,
- faster decision-making,

- more effective communication,
- lower operating costs,
- greater flexibility,
- better customer service.

However, digital transformation also creates challenges. Companies often face high implementation costs, integration difficulties, and cybersecurity risks. Small and medium-sized enterprises may encounter additional barriers due to limited financial and technological resources (Kache & Seuring, 2017).

AUTOMATION AND ROBOTICS

Automation has become one of the most important technological trends in supply chain management. Warehouses, production systems, and transportation operations increasingly utilize automated technologies and robotics solutions.

Automated Guided Vehicles (AGVs), autonomous mobile robots (AMRs), and robotic picking systems significantly improve warehouse efficiency and reduce labor dependency. These technologies increase speed, accuracy, and productivity while minimizing human error (Boysen et al., 2019). Example: intelligent AGV in warehouse (see also Figure 1).

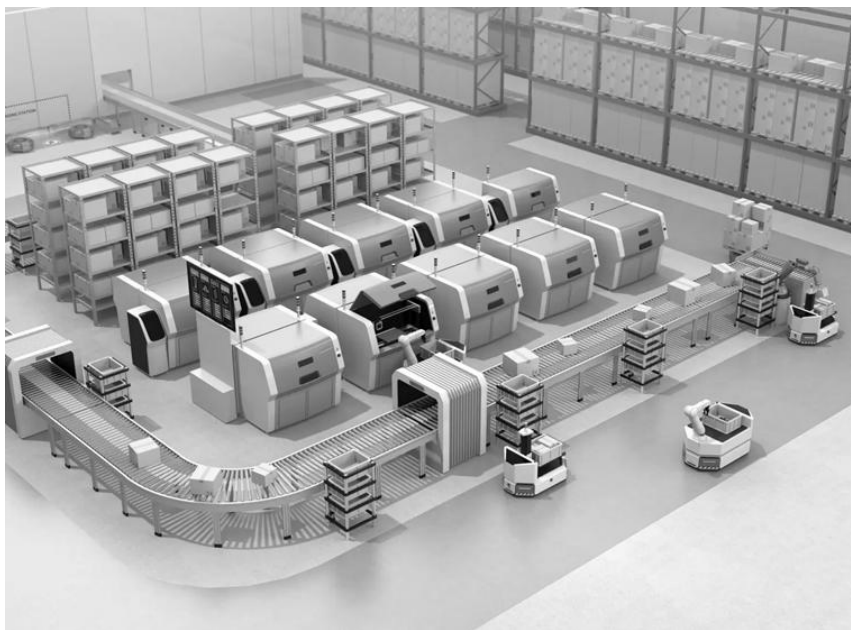


Figure 1: AGV in warehouse (Source: JHCTECH)

The growth of e-commerce has accelerated warehouse automation worldwide. Companies such as Amazon and Alibaba are investing significant amounts of money in robotic logistics centers to meet the ever-growing consumer demand for fast delivery services.

ARTIFICIAL INTELLIGENCE AND BIG DATA ANALYTICS

Artificial intelligence (AI) and big data analytics have radically transformed decision-making processes in the supply chain. Modern supply chains generate vast amounts of data from transportation systems, warehouses, sensors, customer transactions, and manufacturing operations.

Big data analytics improves supply chain visibility and operational transparency. Real-time data processing enables companies to identify disruptions quickly and respond proactively to changing

market conditions (Wamba et al., 2017). Example: top innovations in the supply chains (see also Figure 2).

Applications of AI in supply chains include:

- demand forecasting,
- predictive maintenance,
- route optimization,
- inventory optimization,
- supplier risk analysis,
- customer behavior analysis.

BLOCKCHAIN TECHNOLOGY AND SUPPLY CHAIN TRANSPARENCY

Blockchain technology has emerged as a promising innovation in the field of supply chain management. Blockchain is a decentralized digital ledger system that enables secure, transparent, and immutable data sharing among supply chain participants.

One of the major advantages of blockchain technology is improved traceability. Companies can track products from raw materials to final consumers, which increases transparency and reduces risks for fraud (Saber et al., 2019).

Blockchain applications in supply chains include:

- product traceability,
- smart contracts,
- anti-counterfeiting systems,
- transaction security,
- supplier verification,
- sustainability monitoring.

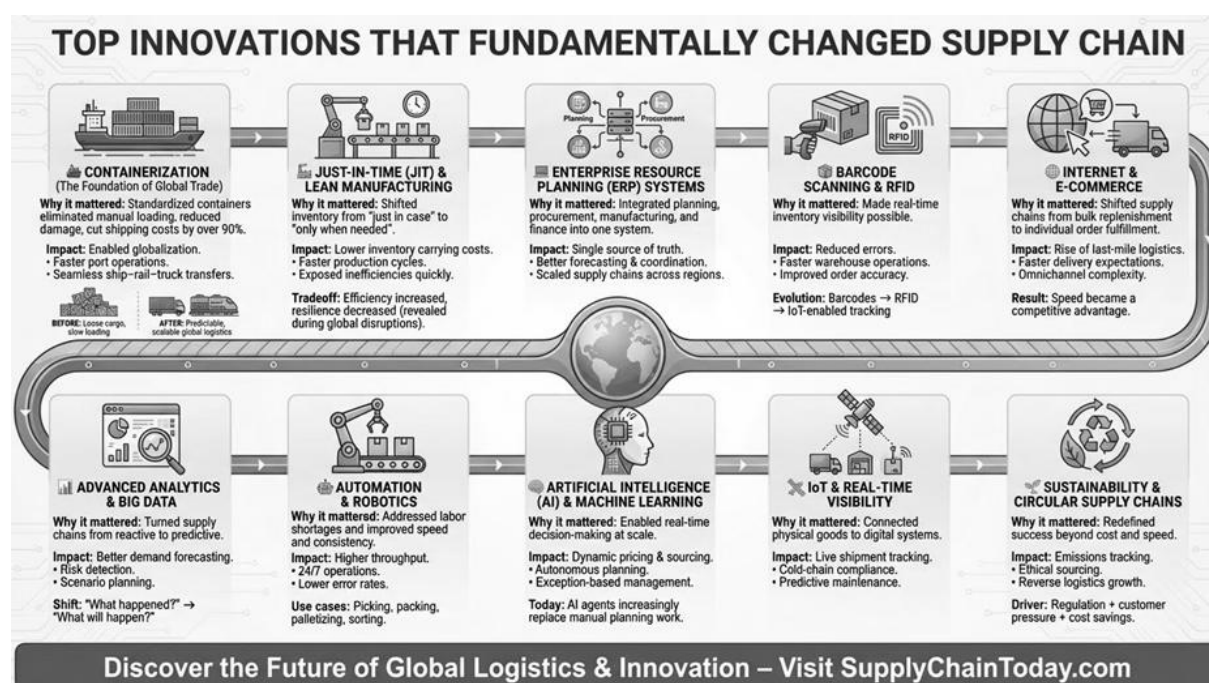


Figure 2: Top innovations in the supply chains (Source: Supply Chain Today)

INTERNET OF THINGS (IOT) AND SMART SUPPLY CHAINS

The Internet of Things (IoT) refers to interconnected devices and sensors capable of collecting and exchanging data through digital networks. IoT technologies have significantly improved supply chain visibility and monitoring capabilities.

IoT systems are especially important in cold chain logistics, where temperature-sensitive products require continuous monitoring. Real-time tracking improves transportation security and reduces the risk of product damage (Ben-Daya et al., 2019).

Smart sensors installed in vehicles, warehouses, and containers provide real-time information regarding:

- location,
- temperature,
- humidity,
- vehicle condition,
- inventory levels,
- delivery status.

SUSTAINABILITY AND GREEN SUPPLY CHAIN INNOVATION

Sustainability has become a central strategic priority in supply chain management. Governments, customers, and investors increasingly expect companies to reduce environmental impacts and adopt sustainable business practices.

Technological innovation plays a crucial role in achieving sustainability objectives. Route optimization software, AI-supported transportation planning, and automated warehouse systems can reduce energy consumption and emissions significantly (Srivastava, 2007).

The green supply chain innovation includes:

- alternative fuel transportation,
- electric vehicles,
- energy-efficient warehouses,
- reverse logistics,
- recyclable packaging,
- carbon footprint reduction strategies.

Sustainable technologies often require substantial financial investment, which may create barriers for smaller enterprises. Example: innovations in supply chain management (see also Figure 3).

CONCLUSION

Innovation and technological change have fundamentally transformed modern supply chains. At the same time, technological transformation also poses significant challenges, including high implementation costs, cybersecurity threats, difficulties in workforce adaptation, and regulatory complexity.

Future supply chains are expected to become increasingly autonomous, interconnected, data-driven, and sustainable. Therefore, organizations must continuously invest in innovation, the development of technological capabilities, and employee training to remain competitive in an ever-changing global business environment.

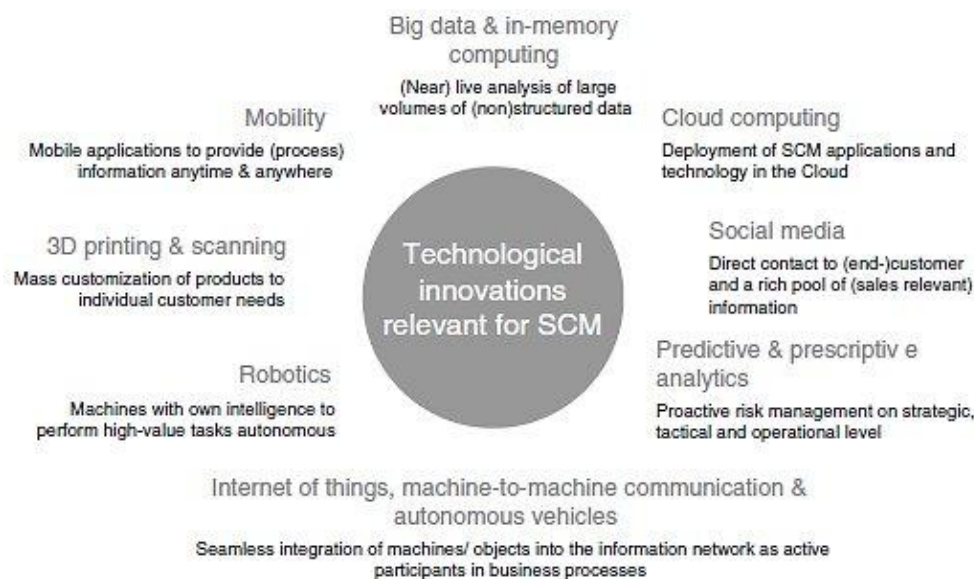


Figure 3: Innovations in supply chain management (Source: Farahani et al., 2017)

Companies that successfully integrate advanced technologies into their supply chain operations can gain significant competitive advantages through improved operational performance and increased customer satisfaction. Furthermore, technological innovation supports sustainability goals and helps organizations respond more effectively to global disruptions and market uncertainty.

REFERENCES

- Ben-Daya, M., Hassini, E., & Bahroun, Z. (2019). Internet of Things and supply chain management: A literature review. *International Journal of Production Research*, 57(15–16), 4719–4742. <https://doi.org/10.1080/00207543.2017.1402140>
- Farahani, P., Meier, C., & Wilke, J. (2017). Digital supply chain management agenda for the automotive supplier industry. In *Shaping the digital enterprise* (pp. 157–172). Springer.
- Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: Extending the supply chain resilience angles towards survivability. *International Journal of Production Research*, 58(10), 2904–2915. <https://doi.org/10.1080/00207543.2020.1750727>
- JHCTECH. (2026). *Intelligent AGV logistics warehousing solution*. Retrieved May 20, 2026, from <https://www.jhc-technology.com/intelligent-agv-logistics-warehousing-solution>
- Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management. *International Journal of Operations & Production Management*, 37(1), 10–36. <https://doi.org/10.1108/IJOPM-02-2015-0078>
- Queiroz, M. M., Ivanov, D., Dolgui, A., & Wamba, S. F. (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, 1159–1196. <https://doi.org/10.1007/s10479-020-03685-7>
- 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>
- Srivastava, S. K. (2007). Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews*, 9(1), 53–80. <https://doi.org/10.1111/j.1468-2370.2007.00202.x>
- Supply Chain Today. (2026). *Top supply chain innovations that transformed the global economy*. Retrieved May 20, 2026, from <https://www.supplychaintoday.com/top-supply-chain-innovations-that-transformed-the-global-economy/>
- Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J.-F., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research*, 70, 356–365. <https://doi.org/10.1016/j.jbusres.2016.08.009>
- Winkelhaus, S., & Grosse, E. H. (2020). Logistics 4.0: A systematic review towards a new logistics system. *International Journal of Production Research*, 58(1), 18–43. <https://doi.org/10.1080/00207543.2019.1612964>