PRINCIPLES AND MODELS OF STOCK MANAGEMENT BEFORE AND AFTER THE PANDEMIC

Goran Vujasinović[1] [0009-0001-3000-7209], Vijoleta Vrhovac[2] [0000-0003-2503-7654], Marina Janković[33][0000-0003-0519-197x], Željko Dudić[44] [0000-0001-8103-2677], Dalibor Jeličić[55] [0000-0001-8145-2268]

Abstract

The main purpose of this work is to examine the current models of inventory management in manufacturing and trading companies and make a comparison with the pre-pandemic period in the context of the supply chain, through relevant and available information. Also, a comparison of stock levels of representative companies, before and after the pandemic, will be presented, in order to draw certain conclusions and possible guidelines. The emergence of the pandemic has led to major changes in the entire supply chain, especially in the domain of inventory management due to unstable and uncertain delivery times. Before the pandemic, in the largest number of companies, the most prevalent principle of inventory management was the JIT (Just in time) approach, however, after the pandemic, the JIC (Just in case) principle was increasingly used, which leads to a higher level of inventory, in order to protect companies from possible disruptions in the supply chain, such as longer delivery times, lack of energy sources, etc. Also, after the pandemic, there is a noticeable trend of Reshoring, i.e. returning production to companies' home countries and diversifying supply chains, in order to reduce supply dependence on one region or continent, due to growing geopolitical challenges. The pandemic has fundamentally reshaped inventory management, forcing companies to rethink their existing strategies, and to adopt more robust, flexible and technology-driven approaches, which enable a comparative advantage in the market, which we want to identify in this paper.

Key words: *Supply chain, Stock management, Pandemic, Flexibility.*

1 University of Novi Sad, Faculty of Technical Sciences, vujasinovicgoran@gmail.com
2 University of Novi Sad, Faculty of Technical Sciences, violeta.vrhovac@uns.ac.rs
3 University of Novi Sad, Faculty of Technical Sciences, marina.jankovic@uns.ac.rs
4 University of Novi Sad, Faculty of Technical Sciences, zeljko.dudic@yahoo.com
5 University of Novi Sad, Faculty of Technical Sciences, dalibor.jelicic@gmail.com

1. Introduction

Inventory or stock management, is a crucial component of supply chain operations, plays a pivotal role in ensuring that businesses can meet customers demand efficiently while minimizing costs (Emmett, 2011; Brodetskiy, 2015). Before the COVID-19 pandemic (2019-2020 year), stock / inventory management primarily were based around established principles designed to optimize and organize inventory levels, reduce holding costs in order to increase cash flow, and streamline operations to have satisfied customers. Many traditional models of inventory management, such as Economic Order Quantity (EOQ) (Brodetskiy, 2015; Rao & Mangal, 2018). Just-in-Time (JIT) (Rao & Mangal, 2018; Singh & Singh, 2013; Fazel, 2013) and ABC analysis (Pandya & Thakkar, 2019), were widely adopted and used to balance efficiency with cost control. These methods relied heavily on stable supply chains and predictable demand patterns and their use gave a excellent results in real life.

However, we were witnesses that the COVID-19 pandemic revealed significant vulnerabilities in these traditional stock management approaches. The unprecedented disruptions in global supply chains exposed the limitations of models that prioritized efficiency over resilience (Tarek, 2022). We have had examples of quarantine of entire cities, closing of borders between countries, closing of seaports that in certain situations prevented any physical movement of goods. As a result, businesses faced great challenges such as sudden shortages, increased lead times, and general supply chain interruptions that had not been accounted for in pre-pandemic and pandemic strategies (Ke et al., 2022).

In response, there has been a substantial shift towards more adaptable and resilient stock management practices. To survive in such situations, companies have adopted new approaches such as Just-in-Case (JIC) inventory models, advanced data-driven forecasting, and enhanced automation to better navigate uncertainty and mitigate risks (Siddiqui et al., 2023).

Before the COVID-19 pandemic, stock management primarily focused on efficiency and minimizing costs through various traditional principles. The global pandemic, exposed vulnerability and susceptibility to unplanned influences in global supply chains and led to significant changes in stock management practices due to fact, that companies had to find ways to meet customer demand.

For example, the Ukraine conflict has disrupted the supply of key commodities and materials, including steel, grain, and energy for European companies, leading to increased inventory levels in many industries reliant on these inputs. Similarly, the Middle East tensions have raised concerns about oil supplies, transportation routes, and commodity market volatility. Companies facing such disruptions are diversifying suppliers and stockpiling essential materials to safeguard against further instability (Michael, 2023; World Bank, 2023).

Several organizations have taken concrete steps to adapt. Automakers like Volkswagen have increased inventory buffers for critical components, such as semiconductors, to avoid shortages (World Bank, 2023). Many companies in those turbolent period, especially in COVID, and after COVID period have shifted to a JIC

model to mitigate risks of supply chain interruptions [12] (Disney et al., 2003; Hongyong & Ha, 2023). These shifts illustrate how global supply chain disruptions (Lafrogne-Joussier et al., 2023), whether from pandemics or geopolitical conflicts, are reshaping inventory management on a fundamental level. For example, a lot of U.S. companies shifted in 2022 from a "just in time" supply chain model to a "just in case" model — essentially carrying more inventory and often use of more suppliers closer to the United States as opposed to reliance on Chinese manufacturing. This shift is expected to increase costs while U.S. consumers are also dealing with historic inflation (Frank, 2022).

This paper explores the evolving and adaptive approaches and practices in inventory / stock management, emphasizing how businesses have transitioned from pre-pandemic models to new strategies focused on building resilience and enhancing adaptability in an increasingly volatile global environment. Additionally, the paper compares pre- and post-pandemic inventory management strategies in table form, offering concise insights into their implications for operational efficiency and supply chain resilience to global change.

2. Theoretical Review

2.1 Stock Management Principles Before the Pandemic

Before the pandemic, stock management focused on efficiency and cost minimization, relying heavily on global supply chains and JIT models, which have been practically used for decades, as proven methods, which were not exposed to global disturbances. The methods and principles that prevailed until this period were:

2.1.1. Just-in-Time (JIT) Inventory

- **Principle**: Minimize inventory holding costs by receiving goods only as needed in the production process. Focused on efficiency, minimizing overstock, reducing warehouse needs, and limiting costs tied up in excess stock (Rao & Mangal, 2018; Singh & Singh, 2013; Fazel, 1997). Highly dependent on a smooth supply chain (Hofmann, 2013), JIT is attributed to the Japanese automaker Toyota Motor Corporation. Executives at Toyota in the 1970s reasoned that the company could adapt more quickly and efficiently to changes in trends or demands for model changes if it did not keep any more inventory in-store than was immediately needed (Ohno, 2019).

2.1.2. Economic Order Quantity (EOQ)

- **Principle**: Determine the optimal order quantity that minimizes total inventory costs, including holding and ordering costs. Calculates when and how much to reorder, balancing carrying costs and stock-out costs (Brodetskiy, 2015; Rao & Mangal, 2018; Render et al., 2017).

2.1.3. ABC Analysis

- **Principle**: Classify inventory into three categories (A, B, C) based on value and usage frequency. 'A' items are high-value, low-quantity; 'B' items are moderate in value and quantity; 'C' items are low-value, high-quantity. Helps focus on more valuable stock (Pandya & Thakkar, 2016; Render et al., 2017; Kehinde et al., 2017). Very often, as part of the ABC analysis, the XYZ analysis is also used, which examines the seasonality of sales, and which provides a basis for decisions regarding the level of inventory (Zenkova & Kabanova, 2018).

2.1.4. Safety Stock

- **Principle**: Keep additionally inventory on hand to prevent stockouts due to demand variability and market disturbances. Levels are determined based on demand forecasts, lead time, and service levels (de Kok & Graves, 2003; Simchi-Levi et al., 2001).

2.1.5. Vendor-Managed Inventory (VMI)

- **Principle**: Suppliers manage and replenish stock based on agreed-upon levels. Companies share real-time sales and inventory data with suppliers to reduce stockouts and excess inventory (Sabila et al., 2018; Disney & Towill, 2003). The most famous example of VMI approach is collaboration between a manufacturer (Procter and Gamble) and a retailer (Wal-Mart). Both major players in their industries, P&G and Wal-Mart found a way to leverage on information technology by sharing data across their mutual supply chains (Grean & Shaw, 2002).

2.2 Stock Management Challenges and Evolving Models After the Pandemic Principles Before the Pandemic

2.2.1. Shift from Just-in-Time (JIT) to Just-in-Case (JIC)

- **Principle**: Maintain higher inventory levels as a buffer/ shock absorber, against supply chain disruptions. Focuses on stocking more goods to protect against uncertainties like factory shutdowns, transportation delays, or supplier failures (McKinsey, 2021; Willy, 2022; Valerie, 2022). By having more inventory than initially forecasted, a company can be confident it will always have stock ready to fulfill customer orders (Hongyong & Ha, 2023; Brakman et al., 2020). JIC inventory management is used in all types of companies and industries. For example, manufacturers maintain extra raw materials, while distributors and retailers hold additional stock of finished goods. This area of inventory management is still not sufficiently covered in scientific works, but it certainly deserves more attention, because companies use it to a significant extent

2.2.2. Demand Forecasting and Data-Driven Models

- **Principle**: Use real-time data analytics, artificial intelligence, and machine learning for accurate demand forecasting. Predictive analytics help adjust inventory levels based on consumer behavior, economic conditions, and external shocks (Vineet, 2023; Ivanov & Dolgui, 2021). By leveraging a wide range of data sources and sophisticated algorithms, data-driven forecasting models can provide more accurate predictions (Kane, 2024).

2.2.3. Omnichannel Inventory Management

- **Principle**: Align inventory management across multiple sales channels (e-commerce, in-store). Integrated systems manage inventories in real time across different channels to meet e-commerce demands and balance in-store inventory (Fernie & Sparks, 2018; Bigcommerce, 2024). In multichannel, it is harder to manage inventory, because each channel is treated as a separate entity. This siloed approach puts the focus on individual touchpoints rather than the overall customer journey and can lead to inconsistencies in the supply chain (Silbermayr & Waitz, 2024). Omnichannel is about providing a joined-up customer experience, no matter which channel the customer visits or which device they prefer to use for browsing and buying. A good example can be some retail chain, which displays the stock of its products online in all its stores, and for example if some customer place order for a product online, everyone in the chain will see that the stock has decreased in a specific store.

2.2.4. Supplier Diversification, Reshoring and Localization

- **Principle**: Reduce reliance on single suppliers or overseas supply chains by diversifying and localizing sources (Alicke et al., 2021). Sourcing from multiple suppliers in different regions to reduce risk of supply chain breakdowns (Stefano et al., 2021; IMD, 2022). Reshoring is the process of bringing manufacturing and part or all of the supply chain back to the home country from a foreign country (Linn and Lanng, 2020). Nearshoring is a similar process but refers to a location near the home country. Reshoring is a long game. The decision-making process does not happen overnight, nor does the movement of a supply chain (Cristopher & Christoph, 2022). The length of time to reshore also depends on how much of a supply chain is moving — whether it's the final assembly point or several tiers of suppliers.

2.2.5. Automation and Technology Integration

- **Principle**: Increase automation in warehouse and stock management for efficiency and accuracy (Baryannis et al., 2019), Here it is very important to make distinguish between digital automation and physical automation. Digital automation involves advanced warehouse warehouse management systems (WMS) that go beyond tracking inventory and orders. Modern WMS are getting

Forging the Future: Pioneering Approaches in Business,
Management and Economics Engineering to Overcome
Emerging Global Challenges - 2024

better at integrating warehouse control system (WCS) features, which help coordinate the real-time activities of automated equipment for smoother operations. These advanced systems combine traditional WMS and WCS capabilities for a more integrated and efficient way to manage your warehouse (SAP, 2024).

Physical automation deals with the hands-on tasks of moving and handling goods, using technologies like automated guided vehicles (AGVs), conveyor belts, and robotics. These solutions help automate tasks such as moving products, sorting, and packaging, reducing the need for manual labor while speeding operations. Adoption of robots, automated guided vehicles (AGVs) (Bluepath, 2024), and advanced warehouse management systems (WMS) (SAP, 2024), to streamline inventory handling.

2.2.6. Resilience and Flexibility Focus

- **Principle**: Supply chain resilience pertains to a supply chain's capacity to recover from disruptions, (Sheffi, 2015) such as natural disasters (Harapko, 2021), economic downturns, or supplier failures, while maintaining its essential functions and delivering products or services to customers. Build resilient supply chains that withstand disruptions and adapt quickly (Economist, 2024). Creating flexible contracts, adding redundancy, and using technology to react faster to disruptions (Gartner, 2024).

3. Discussion

Based on reviewed articles from professional literature in the field of Supply Chain, relevant institutions, as well as published scientific works, a comparison of inventory management models before and after Covid-19 could be shown in the following Table 1

Table 1: Comparison - Inventory Management Models Before and After the Pandemic

Principles/Models	Before the Pandemic	After the Pandemic
Just-in-Time (JIT) vs. Just-in-Case (JIC)	Focus on minimizing inventory (JIT)	Shift towards holding more stock (JIC)
Forecasting	Based on historical data and seasonal trends	Data-driven, real-time analytics & AI
Supplier Strategy	Lean, cost-focused global suppliers	Supplier diversification, reshoring and localization
Safety Stock	Minimal to reduce holding costs	Increased safety stock to manage uncertainty
Automation	Slow adoption	Accelerated adoption of automation & AI
Omnichannel	Limited to traditional supply chains	Integrated online-offline inventory systems

In this paper, we would like to give a few real examples when it comes to increasing inventory levels, but also returning production from foreign countries

(process of localization) due to an uncertain global market and unexpected disruptions in the Supply Chain.

According to publicly available data, the US company NVIDIA has significantly increased inventory, due to unpredictably increased demand, persistent global semiconductor shortages, but also, increased demand for GPUs in gaming industry, AI, and data centres. All those factors have prompted NVIDIA (Figure 1) to build up inventory to ensure product availability and respond to market fluctuations, so Just in Case inventory management model was obviously applied and used (Ann, 2024).
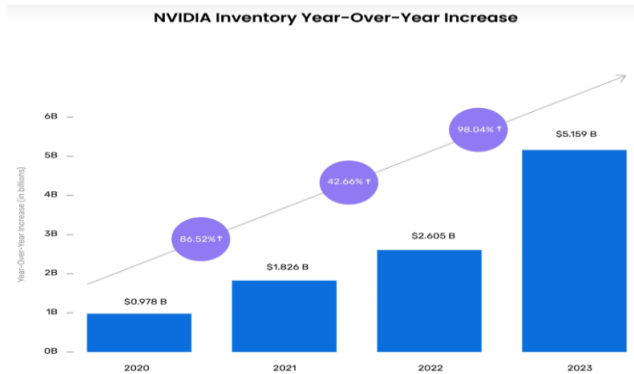

Figure 1: NVIDIA inventory development

The situation with a high level of inventory in the NVIDIA company can certainly be a good basis for further research and determination of the valid reasons that led to such an inventory level.

Regarding Reshoring (localisation), good example of this process is famous company Intel, which announced a \$20 billion investment to build two new semiconductor factories in Arizona, USA. This decision came in response to global supply chain disruptions, including the COVID-19 pandemic and geopolitical tensions like the U.S.- China trade war, which also has a political character (Sabrina, 2021). Similarly, company General Motors has been reshoring its battery production to Michigan in USA, developing a domestic hub for lithium-based products to strengthen its electric vehicle production capacity and make more autonomous supply chain. These reshoring efforts aim to reduce dependency on overseas suppliers and increase supply chain resilience, particularly in sense of the pandemic's challenges (Sabrina, 2021).

Additionally, U.S. Steel is investing in a new plant within the USA rather than abroad, a decision driven by rising steel prices and disruptions in global supply chains. These reshoring trends reflect a broader shift in supply chain strategies post-COVID, with companies looking to mitigate risks by producing critical components domestically or country closer to home country (Sabrina, 2021; Peter, 2022).

In the context of reshoring in Europe, a political recommendation was made as early as 2021, in order to strengthen the European economy and reduce dependence on overseas countries (Raza et al., 2021)

The situation in United Kingdom is very similar, but with transparent figures and statistics, for example, 58% of manufacturers have started to reshore their supply chains - a process in which companies move production from overseas to the countries where goods are sold (Manufacturing & Logistics, 2024).

4. Conclusions

Before the pandemic, stock management primarily aimed at efficiency through JIT principles. The pandemic highlighted the sensitivity and fragility of this model, leading to a shift towards close to the JIC approach, which emphasizes resilience by maintaining higher inventory levels. Companies have increasingly adopted data-driven forecasting, omnichannel management, and technology integration to navigate new challenges. Looking ahead, companies are expected to continue balancing JIC and JIT approaches to maintain resilience while optimizing costs. With the integration and combination of advanced technologies and sustainable practices will likely play a crucial role in shaping future inventory management strategies. Geopolitical uncertainties and ongoing global challenges will further drive the evolution of inventory practices.

Looking further, several key trends are likely to shape the future of stock management and supply chains:

- The integration of advanced technologies as AI (Artificial Intelligence), machine learning, and blockchain will continue to evolve, providing more accurate demand forecasting, improved inventory tracking, and greater transparency across supply chains. Many scientific texts address this topic and explain the advantages and necessity of applying modern technologies (Ammar et al., 2022) and one of the conclusions from the World Economic Forum (Sultan, 2022), confirm, these technologies are crucial for future supply chain efficiency.
- Environmental considerations will become increasingly integral to stock management. Companies are expected to adopt more sustainable practices, such as reducing carbon footprints (CBAM), optimizing resource use, and enhancing waste management, emphasizes the growing importance of sustainability in supply chain strategies (El-Garaihy et al., 2024), which will contribute to companies deciding to adapt to the new facts.
- The emphasis on building more resilient and flexible supply chains will persist. This includes investing in dual-sourcing strategies, localizing production, and developing contingency plans to mitigate the impact of future disruptions. The McKinsey & Company article (Knut & Cengiz, 2022), and observations by MIT (Massachusetts Institute of Technology) (Eric, 2022) provide valuable frameworks for these practices.
- Greater Collaboration and Integration between companies, suppliers, and technology providers will drive more synchronized and efficient supply chains. Real-time data sharing and joint problem-solving will become standard practice, as discussed in book *"The LIVING Supply Chain"* (Handfield, R., & Linton 2017).

- Personalization and Consumer-Centric Approaches, as consumer expectations continue to evolve, supply chains will need to adapt (Rydecki, & Chłąd 2023) by offering more personalized products and services, and by being able to respond swiftly to changing consumer demands. Insights from consulting company Deloitte (Adam, 2020) reflect this trend.

In summary, the pandemic has created the needs for higher inventory (stock level) and requested supply chain management practices that are not only efficient but also resilient and adaptable. Combination and integration of advanced technologies, focus on sustainability, and an emphasis on flexibility will define the future base for supply chain management to make right decisions. Companies which proactively embrace and anticipate these trends will be better positioned to navigate future challenges and seize new opportunities in an increasingly dynamic global market. As we could see from real examples in western countries (USA, EU countries), there has definitely been a change in the way of inventory management, which will certainly remain until global changes become more predictable. Also, the mentioned examples from practice can eventually help modern managers when making decisions in the current, very turbulent environment. Generally speaking, this paper can be a good basis for some future research works, in order to examine the topic in more detail, because it is definitely a paradigm shift in supply chains and it is unlikely that there will be a return to traditional models of inventory management.

REFERENCES

[1] Adam, M. (2020). *Looking beyond the horizon Preparing today's supply chains to thrive in uncertainty*. Deloitte – consultant company. https://www.deloitte.com/mt/en/our-thinking/insights.html

[2] Alicke, K., Barriball, E. D., & Trautwein, V. (2021). How COVID-19 is reshaping supply chains. *McKinsey and Company*, *23*. https://www.mckinsey.com/capabilities/operations/our-insights/how-covid-19-is-reshaping-supply-chains

[3] Ammar, M., Haleem, A., Javaid, M., Bahl, S., & Nandan, D. (2022). Improving the Performance of Supply Chain Through Industry 4.0 Technologies. In P. Verma, O. D. Samuel, T. N. Verma & G. Dwivedi (Eds.), *Advancement in Materials, Manufacturing and Energy Engineering, Vol. II. Lecture Notes in Mechanical Engineering*. Springer, Singapore. https://doi.org/10.1007/978-981-16-8341-1_16

[4] Ann. T. (2024). *How Do Brands and Retailers Manage Excess Inventory?* Metricsart. https://metricsart.com/insights/excess-inventory/

[5] 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

Forging the Future: Pioneering Approaches in Business,
Management and Economics Engineering to Overcome
Emerging Global Challenges - 2024

[6]   Bigcommerce (2024). *Omnichannel Inventory Management*.
      https://www.bigcommerce.com/articles/omnichannel-retail/omnichannel-
      inventory-management/

[7]   Bluepath robotics (2024). Official website.
      https://www.bluepathrobotics.com/revolutionizing-warehousing-the-
      impact-pf-automated-guided-vehicles/

[8]   Brakman, S., Garretsen, H., & van Witteloostuijn, A. (2020). The turn from
      just-in-time to just-in-case globalization in and after times of COVID-19: An
      essay on the risk re-appraisal of borders and buffers. *Social Sciences &
      Humanities Open*, *2*(1), 100034.
      https://doi.org/10.1016/j.ssaho.2020.100034

[9]   Brodetskiy, G. L. (2015). The new approach to inventory optimisation.
      International Journal of Logistics Systems and Management, *22*(3), 251–266.
      https://doi.org/10.1504/IJLSM.2015.072282

[10] Christopher. H. & Christoph. O. (2022). Press release - Official report VW
      Group. https://www.volkswagen-group.com/en/press-releases/volkswagen-
      group-bolsters-expansion-in-global-growth-markets-after-strong-q1-results-
      17171

[11] de Kok, A. D., & Graves, S. C. (2003). *Supply chain management: Design,
      coordination and operation*. Elsevier.

[12] Disney, S. M., & Towill, D. R. (2003). Vendor-managed inventory and bullwhip
      reduction in a two-level supply chain. *International journal of operations &
      production Management*, *23*(6), 625–651.
      https://doi.org/10.1108/01443570310476654

[13] Economist. (n.d.). *Next-gen supply chains: Navigating uncertainty and
      generative AI*. https://impact.economist.com/projects/next-gen-supply-
      chains/

[14] El-Garaihy, W. H., Farag, T., Al Shehri, K., Centobelli, P., & Cerchione, R. (2024).
      Driving sustainability in supply chain management for a more inclusive and
      responsible future. *International Journal of Productivity and Performance
      Management*, *73*(1), 43–84. https://doi.org/10.1108/IJPPM-01-2022-0028

[15] Emmett, S. (2011). *Excellence in warehouse management: how to minimise
      costs and maximise value*. John Wiley & Sons.

[16] Eric, B. (2022). Building resilience for the next supply chain disruption. MIT
      News. https://news.mit.edu/2022/building-resilience-next-supply-chain-
      disruption-james-rice-1121

[17] Fazel, F. (1997). A comparative analysis of inventory costs of JIT and EOQ
      purchasing. *International Journal of Physical Distribution & Logistics
      Management*, *27*(8), 496–504.
      https://doi.org/10.1108/09600039710182680

[18] Fernie, J., & Sparks, L. (Eds.). (2018). *Logistics and retail management:
      emerging issues and new challenges in the retail supply chain*. Kogan page
      publishers.

[19] Frank, H., (2022). *There's a major shift underway in manufacturing for U.S. companies.* CNBC. https://www.cnbc.com/2022/11/04/a-major-shift-is-underway-in-manufacturing-for-us-companies.html

[20] Gartner. (n.d.). *Supply Chain Disruption: Key Strategies for CSCOs.* https://www.gartner.com/en/supply-chain/insights/supply-chain-disruption

[21] Grean, M., & Shaw, M.J. (2002). Supply-Chain Partnership between P&G and Wal-Mart. In M. J. Shaw (Ed.), *E-Business Management. Integrated Series in Information Systems*, vol 1. Springer. https://doi.org/10.1007/0-306-47548-0_8

[22] Handfield, R., & Linton, T. (2017). *The LIVING supply chain: The evolving imperative of operating in real time.* John Wiley & Sons.

[23] Harapko, S. (2021). How COVID-19 impacted supply chains and what comes next. *Ernst & Young*, *18*, 2021. https://www.ey.com/en_gl/insights/supply-chain/how-covid-19-impacted-supply-chains-and-what-comes-next

[24] Hofmann, E. (2013). Supply Chain Management: Strategy, Planning and Operation, S. Chopra, P. Meindl, 5th ed, ISBN:978-0273765226. *Journal of Purchasing and Supply Management*, *19*(3), 212–213. https://doi.org/https://doi.org/10.1016/j.pursup.2013.07.003

[25] Zhang, H., & Doan, T. T. H. (2023, September 1). *From just-in-time to just-in-case: Global sourcing and firm inventory after the pandemic.* CEPR. https://cepr.org/voxeu/columns/just-time-just-case-global-sourcing-and-firm-inventory-after-pandemic

[26] IMD Consulting company (2022). *The localization of global supply chains amid the pandemic.* https://www.imd.org/research-knowledge/supply-chain/articles/the-localization-of-global-supply-chains-amid-the-pandemic/

[27] 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

[28] Kane, M. (2024). *Data-Driven Demand Forecasting: Predestinating Supply Chain Success.* Flowster. https://flowster.app/data-driven-demand-forecasting-predestinating-supply-chain-success/

[29] Ke, J. Y. F., Otto, J., & Han, C. (2022). Customer-Country diversification and inventory efficiency: Comparative evidence from the manufacturing sector during the pre-pandemic and the COVID-19 pandemic periods. *Journal of Business Research*, *148*, 292–303. https://doi.org/10.1016/j.jbusres.2022.04.066

[30] Kehinde Busola, E., Ogunnaike Olaleke, O., & Adegbuyi, O. (2020). Analysis of inventory management practices for optimal economic performance using ABC and EOQ models. *International Journal of Management (IJM)*, *11*(7), 835–848. https://doi.org/10.34218/IJM.11.7.2020.074

[31] Knut, A., & Cengiz. B., (2022). *To build resilience, manage proactively*. McKinsey & Company. https://www.mckinsey.com/capabilities/operations/our-insights/supply-chains-to-build-resilience-manage-proactively

[32] Lafrogne-Joussier, R., Martin, J., & Mejean, I. (2023). Supply shocks in supply chains: Evidence from the early lockdown in China. *IMF economic review*, *71*(1), 170. https://doi.org/10.1057/s41308-022-00166-8

[33] Lin, J., & Lanng, C. (2020, May). Here's how global supply chains will change after COVID-19. In *World economic forum*, *6*. https://www.weforum.org/agenda/2020/05/this-is-what-global-supply-chains-will-look-like-after-covid-19/

[34] Manufacturing & Logistics IT (2024, Jan 04). *UK manufacturers plan to increase reshoring to get better value and more security*. https://www.logisticsit.com/articles/2024/01/04/uk-manufacturers-plan-to-increase-reshoring-to-get-better-value-and-more-security#:~:text=A%20further%2058%25%20of%20manufacturers,reshoring%20process%20report%20successful%20outcomes

[35] McKinsey & Company. (2021). *Building a Resilient Supply Chain Post-COVID-19*. https://www.mckinsey.com/

[36] Michael, E. (2023). *From Ukraine war to Middle East war: Another huge blow to global stability*. Rabobank. https://www.rabobank.com/knowledge/d011397372-from-ukraine-war-to-middle-east-war-another-huge-blow-to-global-stability

[37] Ohno, T. (2019). *Toyota production system: beyond large-scale production*. Productivity press (pp. 20–23). http://dspace.vnbrims.org:13000/jspui/bitstream/123456789/4694/1/Toyota%20Production%20System%20Beyond%20Large-Scale%20Production.pdf

[38] Pandya, B., & Thakkar, H. (2016). A review on inventory management control techniques: ABC-XYZ analysis. *REST Journal on Emerging trends in Modelling and Manufacturing*, *2*(3), 82–86.

[39] Peter. B. (2022). *Push to reshore US manufacturing challenged by reliance on global supply chain*. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/blog/major-copper-discoveries

[40] World bannk (2023). *Conflict in Middle East Could Bring 'Dual Shock' to Global Commodity Markets*. https://www.worldbank.org/en/news/press-release/2023/10/26/commodity-markets-outlook-october-2023-press-release

[41] Rao, V. M., & Mangal, D. (2018). Economic order quantity-a tool for inventory management-a case study. *International Journal of Supply Chain and Inventory Management*, *3*(1), 56–65. https://doi.org/10.1504/IJSCIM.2018.098238

[42] Raza, W., Grumiller, J., Grohs, H., Essletzbichler, J., & Pintar, N. (2021). *Post Covid-19 value chains: options for reshoring production back to Europe in a globalised economy.* Publications Office of the European Union. https://doi.org/10.2861/118324.

[43] Render, B., Heizer, J., & Munson, C. (2017). *Principles of operations management: Sustainability and supply chain management*. Pearson.

[44] Rydecki, J., & Chłąd, M. (2023). Sustainability in global supply chains: a consumer-centric perspective. *Global Journal of Entrepreneurship and Management*, *4*(2), 11–28. https://doi.org/10.57585/GJEM.023.004

[45] Sabila, A. D., Mustafid, M., & Suryono, S. (2018). Inventory control system by using vendor managed inventory (VMI). In *E3S Web of Conferences* (Vol. 31, p. 11015). EDP Sciences. https://doi.org/10.1051/e3sconf/20183111015

[46] Sabrina. K. (2021). *Why US firms are reshoring their business*. Deutsche Welle – DW. https://www.dw.com/en/why-us-companies-are-reshoring-their-business/a-60054515

[47] SAP – official website. https://www.sap.com/products/scm/extended-warehouse-management/warehouse-automation.html

[48] Sheffi, Y. (2015). Preparing for Disruptions Through Early Detection. *MIT Sloan Management Review*, *57*(1), 30–42.

[49] Siddiqui, K. I., Lee, M. M. Y., Koch, T., Dugundji, E. (2023). Case Fill Rate Prediction. In S. Terzi, K. Madani, O. Gusikhin & H. Panetto (Eds.), *International Conference on Innovative Intelligent Industrial Production and Logistics* (pp. 285-303). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-49339-3_18

[50] Silbermayr, L., & Waitz, M. (2024). Omni-channel inventory management of perishable products under transshipment and substitution. *International Journal of Production Economics*, *267*, 109089. https://doi.org/10.1016/j.ijpe.2023.109089

[51] Simchi-Levi, D., Kaminski, P., & Simchi-Levi, E. (2001). Douglas M. Lambert. *Journal of Logistics Management*, *12*(2), 13–36.

[52] Singh, D. K., & Singh, S. (2013). JIT: A strategic tool of inventory management. *International Journal of Engineering Research and Applications*, *3*(2), 133–136.

[53] Stefano. E., Luciano. F., & Paolo. B. (2021). *Post-pandemic reconfiguration from global to domestic and regional value chains: the role of industrial policies*. UNCTAD. https://unctad.org/system/files/non-official-document/diaeia2021d2a3_en.pdf

[54] Sultan, T. (2022, Jan 14). *5 ways the COVID-19 pandemic has changed the supply chain*. World Economic Forum. https://www.weforum.org/stories/2022/01/5-ways-the-covid-19-pandemic-has-changed-the-supply-chain/

[55] Valerie. B. (2022). *The New Supply Chain Mindset: From Just-in-Time to Just-In Case*. SupplyChainBrain. https://www.supplychainbrain.com/blogs/1-think-tank/post/35871-the-new-supply-chain-mindset-from-just-in-time-to-just-in-case

[56] Vineet, J. (2023). *The Role of AI in Forecasting and Where It Falls Short",
Association for Financial Professionals.* AFP USA.
https://www.afponline.org/training-
resources/resources/articles/Details/the-role-of-ai-in-forecasting-and-
where-it-falls-short

[57] Willy. S. (2022). *From Just-In-Time To Just-In-Case: Is Excess And Obsolete
Next?.* Forbes. https://www.forbes.com/sites/willyshih/2022/01/30/from-
just-in-time-to-just-in-case-is-excess-and-obsolete-next/

[58] Zenkova, Z., & Kabanova, T. (2018, April). The ABC-XYZ analysis modified for
data with outliers. In *2018 4th International Conference on Logistics
Operations Management (GOL)* (pp. 1–6). IEEE.
https://doi.org/10.1109/GOL.2018.8378073