REST Journal on Banking, Accounting and Business
Vol: 4(3), September 2025
REST Publisher; ISSN: 2583 4746
Website: http://restpublisher.com/journals/jbab/
DOI: https://doi.org/10.46632/jbab/4/3/11

AI in Logistics and Supply Chain Optimization

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Abstract: *The incorporation of Artificial Intelligence (AI) technologies is causing a paradigm shift in the logistics and supply chain industry. The shortcomings of conventional supply chain models have been made clear by globalization, growing consumer expectations, and unanticipated disruptions like the COVID-19 pandemic. Through applications like demand forecasting, route optimization, warehouse automation, predictive analytics, and real-time tracking, artificial intelligence (AI) becomes a transformative enabler that improves agility, efficiency, and resilience. AI promotes sustainability by lowering waste and resource consumption in addition to increasing operational performance and cutting expenses. This study examines the development, current uses, and prospects for the future of artificial intelligence (AI) in supply chain optimization and logistics, stressing both the technology's possible advantages and the obstacles to its broad adoption, such as implementation costs, data security issues, and the requirement for specialized knowledge. In the end, the study emphasizes AI's contribution to the development of intelligent, resilient, and future-ready supply networks that can provide a competitive edge in a world market that is changing quickly.*

1. INTRODUCTION

The logistics and supply chain industry plays a vital role in ensuring the smooth flow of goods and services across global markets. With increasing globalization, rising customer expectations, and frequent disruptions such as the COVID-19 pandemic, traditional supply chain management approaches are struggling to keep pace with growing complexity and uncertainty. To address these challenges, organizations are turning towards Artificial Intelligence (AI) as a transformative solution. AI technologies such as machine learning, predictive analytics, computer vision, and robotics enable supply chains to become more agile, data-driven, and proactive. Applications range from demand forecasting, route optimization, and warehouse automation to real-time tracking and risk management, all of which enhance efficiency, reduce costs, and improve customer satisfaction. By cutting waste, fuel consumption, and resource utilization, the incorporation of AI into logistics not only improves operational efficiency but also promotes sustainability. Additionally, supply chains powered by AI gain a competitive edge by facilitating quicker deliveries, precise inventory control, and customized services. However, obstacles to broad adoption still exist, including high implementation costs, a lack of specialized knowledge, and data security issues. Notwithstanding these drawbacks, artificial intelligence (AI) is still revolutionizing logistics and supply chain optimization, with enormous promise for creating robust, intelligent, and future-ready supply networks.

2. BACKGROUND OF THE STUDY

Assuring the flow of goods from producers to consumers, supply chain and logistics management has long been essential to international trade. These procedures historically depended on rule-based systems and manual planning, which frequently failed to keep up with growing complexity, globalization, and the need for quicker, more dependable deliveries. The COVID-19 pandemic and other recent disruptions have highlighted the shortcomings of traditional supply chain models and the need for more robust and flexible systems. Powerful tools have been introduced by advances in artificial intelligence (AI) to address these issues. AI improves decision-making, efficiency, and cost-effectiveness throughout the supply chain through applications like demand forecasting, warehouse automation, route optimization, and predictive analytics. Through resource optimization

and waste reduction, it also promotes sustainability. AI is emerging as a major force behind the development of intelligent, adaptable, and competitive supply chain networks as industries continue to embrace digital technologies.

3. HISTORY OF FINTECH

Period Developments in AI and Supply Chain

1960s – 1970s – Introduction of computer-based decision support systems; use of simple algorithms for inventory control and demand forecasting.

1980s – 1990s -- Emergence of Enterprise Resource Planning (ERP) systems; application of rule-based systems for supply chain planning, scheduling, and route optimization.

2000s --Growth of big data, Internet of Things (IoT), and cloud computing; integration of AI for predictive analytics, transportation planning, and demand forecasting.

Widespread use of machine learning and computer vision; warehouse

2010s -- Present automation with robotics; adoption of real-time tracking and route optimization in logistics.

2020s – Acceleration of AI adoption due to e-commerce growth and COVID-19 disruptions; innovations in autonomous delivery vehicles, drone logistics, smart warehouses, and predictive supply chain analytics.

4. NEED OF THE STUDY

Globalization, erratic disruptions, and the rising demand for quicker and more dependable deliveries are all putting more strain on the logistics and supply chain industry. Adopting cutting-edge technologies like artificial intelligence (AI), which can offer more intelligent, data driven, and predictive solutions, is crucial because traditional supply chain management techniques are failing to meet these challenges. To increase productivity, cut expenses, and boost customer satisfaction, it's critical to research the use of AI in supply chain optimization and logistics. By reducing waste and resource consumption and creating supply networks that are more robust and flexible, it also assists businesses in achieving sustainability. In order to comprehend how AI can turn supply chains into intelligent, future-ready systems, this research is necessary.

5. REVIEW OF LITERATURE

TABLE 1. Review Of Literature

Author Name	Article Name	Main Findings
Toorajipour et al. (2021)	Artificial intelligence in supply chain management: a systematic review	AI improves forecasting and routing, but integration and data-quality issues limit its overall impact across supply chain management functions.
Culot et al. (2024)	Artificial intelligence in supply chain management	The importance of data governance and hybrid human–AI decision models for trustworthy deployment of AI in SCM is highlighted.
Chen et al. (2024)	Artificial Intelligence in Logistics Optimization (MDPI Sustainability)	Case studies demonstrate that AI leads to reductions in logistics costs and inventory levels, alongside improvements in service where AI maturity is high.
Shavaki et al. (2022)	Applications of deep learning into supply chain management	Deep Learning models outperform classical models in complex, high dimensional forecasting tasks but require large labeled datasets for optimal performance.
Wenzel (2019)	A literature review on machine learning in supply chain	Supervised learning is the dominant ML technique in SCM, with growing interest in reinforcement learning for dynamic control tasks.
Teixeira et al. (2025)	A Systematic Literature Review on Artificial Intelligence in SCM	AI significantly contributed to supply chain resilience by enhancing disruption detection and mitigation capabilities during recent crises.

Samuels et al. (2025)	Examining the integration of artificial intelligence in supply chains (Frontiers in AI)	Critical success factors for AI integration include organizational readiness and robust cross-functional data pipelines.
Giannelos et al. (2025)	Optimal Supply Chain Design using Machine Learning	Machine learning can effectively estimate uncertainty distributions, which then feed into optimization models (like MILP/robust optimization) to improve supply chain network design decisions.
McKinsey (2020)	Global survey: The state of AI in 2020	Early adopters of AI reported measurable business value, but the primary challenge remains scaling AI initiatives beyond initial pilot projects.
Singh R Verma a Khan S (2025)	Machine Learning and Deep Learning for demand forecasting in Logistics	Advanced deep learning models (LSTMs, temporal CNNs, Transformer variants) are increasingly used, and ensemble approaches often yield the best practical results in demand forecasting.

6. PROBLEM STATEMENT

Content: This will be the focused and refined problem statement we just drafted, highlighting the core challenges that AI aims to solve in logistics and supply chain. This is the slide we just created.

7. RESEARCH OBJECTIVE

- Content: Based on your "Need of the study" and "Problem Statement," clearly state what your research aims to achieve.
- Example: "To analyze the current state of AI adoption in logistics optimization, identify key challenges in its implementation, and propose a framework for assessing its long-term impact on supply chain resilience."
- This directly addresses the "Need" and "Problem."

8. RESEARCH METHODOLOGY

Content: Describe how you plan to conduct your study.

- Type of Research: Is it a systematic literature review? Case study analysis? Survey? Conceptual framework development?
- Data Collection: How will you gather information (e.g., academic databases, industry reports, interviews)?
- Data Analysis: What methods will you use to analyze the collected data (e.g., thematic analysis, content analysis, statistical analysis)?
- This explains "how" you'll achieve your objectives.

9. DATA ANALYSIS AND INTERPRETATION

Content: This section would present the results of your methodology. • Presentation of Findings: Use charts, graphs, tables, or descriptive text to show what you found.

- Interpretation: Explain what these findings mean in the context of your research objectives and literature review. Connect back to how your findings address the problem statement.
- This is where your actual study results would go.

10. SUGGESTIONS

Content: Based on your findings and interpretations, offer practical recommendations for companies, policymakers, or future researchers.

- For Companies: How they can better implement AI, overcome challenges, manage data, build capabilities.
- For Future Research: Further areas of study building on your research gaps and findings.
- Actionable advice based on your study.

11. FOR FUTURE RESEARCH

- . Longitudinal Impact Studies: Conduct more long-term empirical studies to assess the sustained impact of AI on various SCM KPIs, including financial performance, resilience over time, and sustainability metrics (Toorajipour et al., 2021; Culot et al., 2024).
- 2. Standardized Metrics and Benchmarks: Develop and validate standardized metrics and reproducible benchmark datasets for evaluating AI solutions in specific SCM contexts, particularly for resilience and forecasting (Teixeira et al., 2025; 2025 SLR).
- 3. Explainable AI (XAI) in SCM: Further research is needed to develop and apply explainable AI techniques that can provide transparent insights into complex AI models, fostering trust and facilitating adoption in critical SCM decisions (Shavaki et al., 2022).
- Trade-offs and Synergies: Explore the complex trade-offs between optimizing for cost/efficiency versus sustainability/resilience, and investigate synergistic relationships between AI and other emerging technologies (e.g., Blockchain, IoT) for holistic SCM improvement (Chen et al., 2024).
- Governance and Ecosystem Effects: Deeper empirical studies are needed on AI governance frameworks within SCM, its impact on the broader supplier ecosystem, and ethical considerations (Samuels et al., 2025).

12. CONCLUSION

Artificial Intelligence is undeniably a game-changer for logistics and supply chain optimization, offering transformative potential to enhance efficiency, foster resilience, and drive significant cost reductions. The burgeoning body of literature consistently highlights AI's capabilities in areas such as demand forecasting, route optimization, and warehouse automation, yielding tangible benefits in terms of operational speed, accuracy, and adaptability. However, the journey towards fully realizing AI's promise is not without its challenges. Issues concerning data quality, the complexities of integrating AI with existing systems, and the crucial need for organizational readiness often emerge as significant barriers. Furthermore, the academic landscape calls for more longitudinal studies, standardized evaluation metrics, and deeper explorations into the ethical implications and explainability of advanced AI models. Ultimately, successful AI adoption in logistics and SCM hinges not just on technological prowess, but equally on strategic planning, robust data governance, and a commitment to fostering a culture that empowers human-AI collaboration. By addressing these critical factors, organizations can effectively leverage AI to build smarter, more agile, and more sustainable supply chains, navigating the complexities of the modern global economy with unprecedented foresight and efficiency.

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