ARTIFICIAL INTELLIGENCE AS A TOOL OF LOGISTICS INNOVATIONS AND SOLUTIONS

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Abstract

This article discusses artificial intelligence (AI) as a tool of logistics innovations and solutions. A brief history shows how Professor John McCarthy contributed to the concept in 1956. Desouza, et al. (2007) identified five stages of innovation: idea generation and mobilization, advocacy and screening, experimentation, commercialization, and diffusion and implementation. These stages define an innovation process that makes companies more valuable in the future. Incoming logistics, outgoing logistics, and supporting activities are the use cases that show what tasks are controlled by innovative AI. In this research, we analyzed published literature. This led the researcher to believe that AI will help in automating processes, making better decisions, and lowering operational costs. Ultimately, this will result in faster delivery and increased customer satisfaction.

Keywords: Artificial intelligence, supply chain management, automation, digital transformation, AI in logistics

Introduction

Artificial intelligence is not a novel concept. In 1956, Stanford computer science professor John McCarthy coined the term while arranging a summer conference on the subject at Dartmouth College. Subsequently, AI has experienced a succession of boom-bust cycles, characterized by technological advancements that incite excitement followed by 'AI Winters' as technical constraints are revealed. Technology is revolutionizing the logistics industry, which transports, stores, and oversees goods globally. Digital platforms and freight exchanges facilitate information sharing for both horizontal and vertical collaboration, thereby aligning transport planning with supply chain planning. In recent years, several digital logistics platforms and supply chain exchanges, such as Infor Nexus, have generated new options for visibility and collaboration in supply chain planning (Chung, 2021).

Logistics networks are rapidly utilizing AI to boost efficiency, customer satisfaction, and costs. AI's data processing, decision-making, and forecasting skills are projected to outperform conventional supply chains and promote diversification in SCM (Culot et al., 2024; Attah et al., 2024). Machine learning, natural language processing, robotics, and computer vision help AI resemble human intelligence and boost efficiency. Logistics improves routing, warehouse automation, demand forecasting, inventory management, and autonomous vehicle support using AI. Logistics management in supply networks faces demand fluctuations, workforce shortages, and transportation delays (Petrudi, 2022). As globalization and just-in-time inventories enhance supply chain vulnerabilities, disruptions worsen. In the COVID-19 pandemic, these difficulties produced delays, shortages, and financial losses (Kraus et al., 2021; Dovbischuk, 2022). These issues require novel supply chain strategies to boost flexibility, visibility, and resilience. This article will discuss AI methods and evaluate their logistics effectiveness. This function and algorithm save time, energy, and travel costs and improve performance. This may improve demand response, lead times, and costs. AI greatly impacts supply chain management. Supply chain logistics companies can use AI to track freight forwarding and estimate cargo needs (Wu et al., 2025).

Research aim is to demonstrate improvement possibilities in logistics using artificial intelligence as a focal point.

Objectives:

1. To examine artificial intelligence and how they are applied in logistics processes.
2. To identify the benefits and challenges of applying innovation and solution in logistics processes.

Research objects and methods

Research object – Logistics Processes improvement using artificial intelligence and innovations.

This study used a systematic literature review, a common academic research strategy. Peer-reviewed academic publications from Google Scholar databases, Science Direct, and JSTOR were used to write this work. The following keyword where used: Artificial intelligence, supply chain management, automation, digital transformation, AI in logistics. Multistep screening was used to verify article relevance. Initially, 150 internet articles were selected by title. On content, 170 of 200 publications were deleted, leaving 31 for this study. This literature review synthesizes and evaluates AI research in logistics and SCM without testing. However, the articles were also assessed for research relevance, quality, and rigor to the study's goals. This study uses systematic review because it is objective and robust for assessing existing knowledge on a topic. It also allows a thorough assessment of AI, logistics, and SCM research potential and gaps.

Research results and discussion

The History and Overview of Artificial Intelligence

AI in Supply Chain Management has many uses (Grzybowski et al., 2024). AI can improve supply chain performance for all companies (Abideen et al., 2023). L&SCM impacts operational procurement through chatbots and

intelligent data, supply chain planning for demand forecasting, expedited and precise shipping to reduce transportation costs and lead times, optimal supplier selection using real-time data, and warehouse management for stock organization. Overreliance on AI algorithms may hide human talents, maintaining balance, according to Bahoo et al. (2023). Information confidentiality and integrity require upstream supply chain data security and privacy risk assessments.

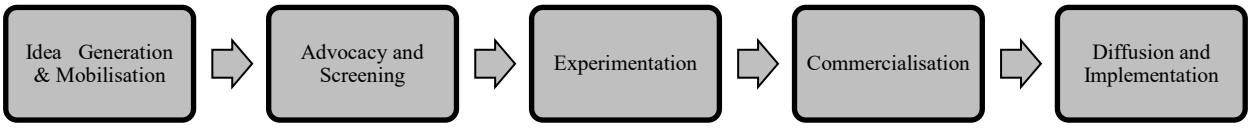
The concept of AI is not new. Stanford computer science professor John McCarthy invented the term in 1956 while organizing a summer conference at Dartmouth College. Since then, AI has gone through multiple booms and bust cycles, with technological advancements sparking excitement and involvement followed by 'AI Winters' of disappointment and indifference when technical limitations were discovered. Autonomous Vehicles (Avs), Autonomous Robots (Ars), and Unmanned Aerial Vehicles (UAVs) are being deployed (Sohrabi, 2023). These developments modify many logistical processes and transportation networks, creating new scheduling, optimization, and solution methodologies in this smart technology era.

The European Parliament defines AI as the capacity of a machine to exhibit human-like qualities, including reasoning, learning, planning, and creativity. Employing intricate algorithms, it autonomously applies acquired methodologies to novel jobs, supplanting programs that must be manually authored by humans for each specific task in a rule-based if/then framework. A 2017 Tungsten Network survey indicated that organisations spend 6,500 hours per year on mundane procedures like supplier inquiries, purchase order modifications, and documentation processing (Pomponi et al., 2013). Many companies now employ AI for supply chain and logistics.

Grzybowski et al. (2024) claim AI can improve logistics and SCM technology. Robotic process automation, speech recognition, computer vision, deep learning, and machine learning simplify complex operations and decisions. Richey et al. (2023) found that these tools can help firms restructure, create procedures, change rules, and add value through varied improvisations. Park et al., (2021) found that logistics and supply chain executives want fast, data-driven decisions. Their data shows that overvalued blockchain technology investors had a stock price boom a few years ago, which is predicted to repeat. Technology facilitates communication between people, products, information, and funds, hence logistics and SCM and research often speculate excessively. According to Kirono et al. (2019), AI is seen as fundamentally distinct from past technologies.

Phases of the emergence of successful innovations

Acccording to Desouza et al. (2009) could be identified five phases of sucessful innovation (see figure 1).



Source: according to Desouza et al. (2009)

Figure 1. Phases of sucessful innovation,

1. Idea Generation and Mobilization.

Ideas can be generated in playful, easy-going environments (Dombrowski et al., 2007) or in need-based environments. The generating phase serves as the inception point for novel concepts. Effective idea generation must be driven by competitive pressure as well as the liberty to investigate. IDEO (1991), a product development and branding firm located in Palo Alto, California, exemplifies an organization that fosters effective idea generation by striking a balance between playfulness and necessity. This phase is crucial for the advancement of a novel concept and omitting it can hinder or even undermine the innovation process.

2. Advocacy and screening.

Must happen simultaneously to reject ideas with little potential and avoid stakeholders from ignoring fresh ideas. The authors found that clear and uniform evaluation processes improved company performance because employees felt more comfortable participating when they understood how their ideas would be evaluated. Innovation Mentors help people pitch management ideas after a corporate strategy and analysis training programme (Gao, 2010).

3. Experimentation.

The experimental phase tests ideas for a given organization and environment. Now is the time to determine the consumer and the innovation's intended use. Thus, the company may discover that an innovative idea is premature or unsuited for a particular market. These findings may inspire new and better ideas, so don't view them as failures. Resources must be available to experiment, and process leaders must be allowed time to do so and reflect on the results to modify and evaluate. This can be outsourced for product development and user reaction testing (Burmaoğlu et al., 2015).

4. Commercialization.

The organization should consult its consumers to confirm that the innovation effectively addresses their issues, followed by an analysis of the costs and advantages associated with its implementation. The authors emphasize that an invention is deemed an innovation only after it has been commercialized (Borodavko et al., 2021).

4. Diffusion and Implementation.

Three potentially effective strategies for the diffusion of ideas include: 1) identifying key actors to align the organization for knowledge management by engaging all levels and cultivating internal alliances with diverse

stakeholders; 2) leveraging existing initiatives and actively promoting knowledge networks to create momentum by connecting decentralized efforts and underscoring the company mission; and 3) conveying a deliberate message that facilitates cultural and cognitive transition by concentrating on achievable objectives (Dombrowski et al., 2007).

Theories of Innovations

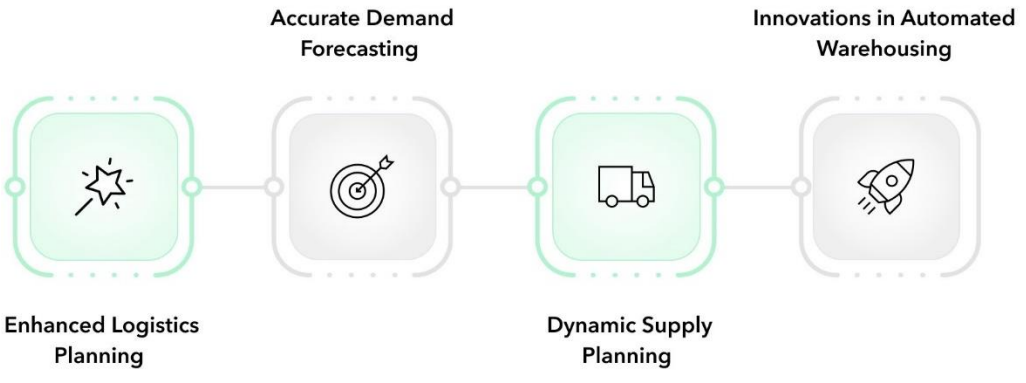
1.**Open Innovations Models.** Open innovation is not just a trend but a revolutionary force changing organizational creativity. It marks a departure from covert innovative methods. It acknowledges the boundless creative potential outside an institution. Open innovation requires a well-planned innovation strategy. This strategy ensures that the organization's creative endeavours are intentional, strategic, and linked to long-term success, establishing a strong innovation culture throughout the process (Buijs et al., 2012).

2.**Diffusion of Innovation.** The process by which an innovation is conveyed through specified channels over time among members of a social system is called diffusion (Rogers 2003, p. 5). People creating and exchanging information to understand each other is called diffusion. As a fresh idea in communication, diffusion is ambiguous. In Rogers (2003, p. 9), uncertainty is "the extent to which multiple alternatives are recognized concerning the occurrence of an event and the associated probabilities of these alternatives." On p. 232, he called the DOI "an uncertainty reduction process" and offered innovations that reduce uncertainty through information collection.

3.**Schumpeter's Creative Destruction.** From Schumpeter's viewpoint, the capitalist system is perpetually evolving, leaving no space for stagnation. He thus underscored the necessity of analysing the significance of competition concerning the flexibility of capitalism inside economic models. He asserts that the essential component of capitalism is creative destruction (Langroodi, 2021). His thesis posits that economic development is propelled by a process of innovation that disrupts and supplants existing systems.

AI use cases in logistics

In the field of logistics, what kinds of use cases may AI have an impact on? It is not difficult to understand the answer: almost all along the value chain. The following is an outline of the activities that are included in this, which includes: Enhance logistics planning, Accurate demand forecasting, Dynamic supply planning, Innovations in automated warehousing (see figure 2).



Source: Rapidops.com, 2024

Figure 2. AI use cases in logistics

Accurate demand forecasting. Employing real-time data, AI-driven forecasting techniques markedly diminish mistake rates in comparison to conventional methods. This precision facilitates effective vehicle deployment, workforce organization, and minimized operational expenses (rapidoPs, 2024). AI and robotics are crucial for optimizing picking and packing processes. The expansion of digital commerce in recent years and the increase in individual order deliveries to e-consumers (Yuan et al., 2025) have made logistics more dynamic to meet an increasingly varied demand (Castillo et al., 2018).

Dynamic supply planning. The real-time demand analysis conducted by AI facilitates the dynamic adjustment of supply planning parameters, optimizing supply chain efficiency and reducing resource waste (Huo et al., 2018; rapidoPs, 2024). Artificial intelligence and other technologies are transforming critical support processes across the logistics value chain. The challenge of environmental sustainability in e-commerce entails the implementation of effective strategies and tools for managing online orders and deliveries, considering customer satisfaction, economic and environmental costs, and the impact of traffic congestion (Jeong et al., 2024).

Enhanced logistics planning. The foundation of logistics planning is provided by machine learning solutions, which are skilled at handling scenario analysis and numerical analytics that are essential for effective supply chain coordination (rapidoPs, 2024). Logistics planning model integrates services and supervises information management tactics to augment client value while ensuring cost efficiency (Chen et al., 2021).

Innovation in automated warehousing. AI-powered warehouse solutions, including robotics, are anticipated to achieve over 60% penetration by 2026, hence improving supply chain management. The expansion of the warehouse robotics business highlights the investment and trust in AI's function in automating warehousing processes (rapidoPs, 2024). IoT solutions are essential for enhancing inventory management and augmenting real-time stock visibility.

Research conducted by Chowdhury et al. (2024) demonstrates how IoT may expedite corporate operations and improve traceability.

Benefits of applying AI on Logistics and SCM

1. Automation technologies have transformed supply chain management by minimizing human involvement, eradicating errors, and enhancing efficiency. Proper automation etiquette can improve performance, trust, motivation, confidence, and job satisfaction in roles involving both personified and non-personified technology (Attah et al., 2024). Automation influences fully automated retail operations equipped with robotic equipment capable of swiftly and accurately picking, packaging, sorting, and palletizing. A contemporary warehouse requires innovations such as Autonomous Mobile Robots (AMRs) and Automated Guided Vehicles (AGVs) to minimize labour input and eradicate human errors (Bahoo et al., 2023).

2. Logistics **predictive analytics** quantitatively and qualitatively assesses material transportation, storage, costs, and service. Evaluating historical and prospective business process integration, pricing, and service standards enhances supply chain architecture and competitiveness. Previous studies have separately investigated the association between companies' utilization of big data and open innovation (Borodavko et al., 2021), as well as the link between open innovation and market success (Luu, 2025). Predictive analytics use sophisticated analytics to anticipate demand, optimize inventory levels, and improve overall decision-making processes (Sohrabi, 2023).

3. Route optimization evaluates time, distance, and cost to determine the most economical and efficient path between locations. Route optimization in transportation and logistics conserves time and resources. It is applicable for fleet management or individual travel. Software and algorithms ascertain the optimal route based on inputs. Inputs may encompass initial and final destinations, intermediate stops or points of interest, mode of transportation, and limits or preferences (e.g., evading highways or neighbourhoods). Statistical data indicates that the transportation sector contributes around 20% to total world carbon emissions (Kraus et al., 2021). Unregulated carbon emissions will intensify global warming. Optimization indicates a route that satisfies the requirements.

4. The **inventory management** system is an essential element of a proficient and productive supply chain. It is defined by Culot et al. (2024) as the segment of supply chain management that strategises, executes and regulates the efficient and effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption to meet customer demands. Park et al. (2021) assert that digital technologies enable the creation of diverse new business models, transforming existing ones and providing a novel medium for communication and engagement with customers and other stakeholders.

Challenges and barriers to implementation of innovations

Based on the literature review, the main challenges and barriers to innovation implementation can be identified.

1. Technological Challenges. Advanced supply chain analytics improves efficiency, cost, and decision-making. These benefits are hindered by technology. Data integration—combining data from several sources to create an analysis-ready image is a major issue. Traditional supply chains gather data from suppliers, factories, warehouses, transportation networks, and customers. Integration is difficult since these data points are often housed in different systems, formats, and databases. To secure SCRM technology, security methods must be updated as cyber threats change (Chen et al., 2021). Storage and transmission of sensitive data must comply with standards for data security and privacy.

2. Organizational Challenges. Alongside technological challenges, the use of advanced analytics in supply chain management faces significant organizational issues. Resource allocation is necessary for organizations to acquire hardware, software, and integrate new systems with existing infrastructure (Desouza et al., 2009). The swift advancement of AI has significantly transformed task execution, modified conventional processes and required new competencies (Attah et al., 2024). Employees may encounter uncertainty or reluctance in adjusting to these changes, affecting morale and productivity.

3. Regulatory and Ethical Considerations. Advanced supply chain analytics must meet ethical and regulatory constraints, including data privacy. Gathering, storing, and analysing large volumes of sensitive customer, supplier, and employee data is advanced analytics. GDPR and CCPA restrict data collection, processing, and dissemination. Organisations that break these rules risk legal, financial, and reputational consequences (Castillo et al., 2018). Ethical data use is crucial. Companies must address ethical data processing issues while following laws. For instance, sophisticated analytics can assess employee performance and conduct, raising monitoring and data exploitation issues. Customer demand forecast analytics may unfairly affect purchase. Cyber dangers are always changing, therefore SCRM technology must be protected by adapting security protocols (Chen et al., 2021). Data security and privacy need compliance with many standards for storing and transporting sensitive data.

Conclusions

1. AI can be defined as the capacity of a machine to exhibit human-like qualities, including reasoning, learning, planning, and creativity. The employment of sophisticated algorithms enables autonomous application of acquired methodologies to novel tasks, thereby superseding programs that are manually authored by humans for each specific task within a rule-based if/then framework. The implementation of AI enhances efficiency through process automation, decision-making improvement, and operational cost reduction.

2. Innovations which range from route optimization, demand forecasting, inventory management, and warehouse operation enhancement, ultimately leading to expedited delivery and heightened customer satisfaction. AI is a promising technological instrument capable of enhancing the supply chain performance of any organization. By accurately

forecasting customer demand, organizations can minimize surplus inventory, prevent stockouts, and optimize inventory levels. Predictive analytics identifies trends and patterns that may be undetectable with conventional analytical techniques, enabling companies to make more decisions. The logistics and transportation sectors are seeing a transition driven by artificial intelligence, offering significant prospects for enhancement and efficiency.

3. Although AI has emerged as a primary focus for supply chain management executives, numerous implementation challanges and barriers impede its effective adoption. Main of them are technological and organizational challenges, regulatory and ethical considerations.

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