

Unleashing the Power of AI and Information Systems in Supply Chain Management

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Abstract

This paper examines the transformative role of Artificial Intelligence and information systems in Supply Chain Management, focusing on their impact on operational efficiency, risk management, and customer satisfaction. Key applications such as predictive analytics, AI-driven demand forecasting, and Decision Support Systems are explored, illustrating how these technologies enhance forecast accuracy, reduce inventory costs, and optimize logistics. The integration of AI and information systems is highlighted as a driver of a more interconnected, data-driven supply chain. Challenges such as data security, system integration, and workforce readiness are addressed, along with strategies for achieving seamless interoperability. The paper also proposes future research on the application of AI in the organ transplantation supply chain in Morocco as a case study for validation. The findings underscore AI's potential to revolutionize SCM through strategic integration and technological advancements.

Keywords

Supply Chain Management, Artificial Intelligence, Integration, Predictive Analytics, and Interoperability.

1. Introduction

In the ever-evolving landscape of Supply Chain Management (SCM), external forces, changing consumer behaviors, and technological progress continually shape this dynamic arena. Johnson and Smith's (2021) review underscores the need for adaptive strategies in SCM. The traditional focus on efficient goods movement has transformed, driven by technological advancements, global interconnectedness, and consumer expectations. Integration of technologies like Artificial Intelligence (AI), the Internet of Things (IoT), and data analytics has shifted SCM from reactive to proactive models.

Globalization has interconnected supply chains across borders, necessitating real-time visibility, communication, and collaboration. Sustainability considerations are now integral to SCM, with eco-friendly practices and circular supply

chain models becoming prominent. In conclusion, the evolving SCM landscape demands adaptation to advanced technologies, global networks, sustainability, and circularity for organizations to remain competitive and responsive. The growing significance of AI and information systems marks a transformative era in SCM. Leveraging AI for predictive analytics enables proactive adjustments to inventory, logistics, and overall responsiveness, enhancing customer satisfaction.

Advanced demand forecasting with AI optimizes inventory levels and reduces operational costs. Decision support systems (DSS) powered by AI contribute to efficient decision-making in logistics and production planning. The integration of information systems complements this transformation, fostering seamless communication and real-time visibility across the supply chain. In summary, the symbiotic relationship between AI and information systems elevates SCM to new heights of operational excellence, creating a more intelligent, responsive, and interconnected supply chain ecosystem. In summary, the growing significance of AI and information systems in optimizing SC processes heralds a new era of efficiency and adaptability in SCM. Predictive analytics, advanced demand forecasting, and DSS driven by AI, when integrated with robust information systems, collectively elevate SCM to new heights of operational excellence. This symbiotic relationship between AI and information systems not only enhances the performance of individual supply chain components but also contributes to the creation of a more intelligent, responsive, and interconnected supply chain ecosystem.

1.1 Objectives

The objectives of this research are as follows:

- To explore the impact of AI on optimizing supply chain processes such as demand forecasting, inventory management, and route optimization.
- To assess the potential benefits and challenges of AI integration within existing supply chain frameworks.
- To propose strategies for overcoming the barriers to AI adoption in supply chains, including workforce readiness, data security, and system integration.

By the end of this paper, the research will have demonstrated the transformative potential of AI in SCM and provided practical recommendations for its adoption.

2. Literature Review

Recent advancements in integrating AI with information systems have demonstrated significant improvements in healthcare supply chain management (Guetibi 2024). These advancements include enhanced operational efficiency, improved decision-making, and better resource allocation, as highlighted in previous research (Guetibi 2024). AI technologies such as machine learning, predictive analytics, and robotics have shown potential in transforming supply chains by enabling real-time data processing, improving operational efficiency, and reducing human errors. This section explores three key applications of AI in SCM: Predictive Analytics, Demand Forecasting, and DSS. It details the role of Predictive Analytics in foreseeing market trends and demand fluctuations, supported by real-world case studies. Additionally, it delves into how AI enhances accuracy in forecasting demand, providing concrete examples of improved demand planning. The section also highlights the benefits of DSS in making intelligent decisions for optimizing logistics and resource allocation.

Predictive Analytics

Predictive analytics leverages historical data, statistical algorithms, and machine learning to forecast market trends and demand fluctuations. This capability enables organizations to optimize inventory management, enhance customer satisfaction, and improve operational efficiency. For example, Amazon uses predictive analytics for dynamic pricing and inventory management, adjusting prices in real-time based on demand, competitor pricing, and inventory levels. This approach has reportedly improved forecast accuracy by 15% and reduced inventory costs by 10% (Wang et al. 2018). Similarly, Walmart employs predictive analytics for seasonal demand forecasting, ensuring optimal stock levels for products like holiday decorations. This has led to a 20% reduction in overstocking and a 12% increase in customer

satisfaction during peak seasons. These examples illustrate the transformative impact of predictive analytics on SCM (Cyril et al. 2024).

Demand Forecasting

AI-driven demand forecasting surpasses traditional methods by analyzing vast datasets, including historical sales data, market trends, and external factors like weather patterns. For instance, Coca-Cola uses AI to optimize inventory levels, reducing excess stock by 18% and improving product availability by 22% (Brown & Lee, 2020). These improvements highlight the role of AI in enhancing forecast accuracy and operational efficiency.

Decision Support Systems

DSS powered by AI optimizes logistics, resource allocation, and production planning. UPS, for example, uses AI to optimize delivery routes, reducing fuel consumption by 8% and improving delivery times by 12% (Li & Zhang, 2019). These systems enable organizations to make data-driven decisions, enhancing overall supply chain performance. Leveraging AI for intelligent decision-making in SCM proves to be a strategic initiative, enriching the efficiency, accuracy, and adaptability of decision processes across diverse SCM functions. Within this context, AI plays a pivotal role in various aspects of intelligent decision-making:

In the realm of Demand Forecasting and Planning, AI analyzes historical data, market trends, and external factors to forecast demand accurately. Intelligent decision-making in demand planning entails optimizing inventory levels, production schedules, and distribution strategies based on AI-generated insights, ensuring proactive and data-driven responses to changes in demand. Dynamic Inventory Optimization is achieved through AI's continuous analysis of real-time data, dynamically adjusting inventory levels. Intelligent decision-making in inventory management involves adapting stock levels based on changing demand patterns, minimizing holding costs, and preventing stock outs or excess inventory. AI algorithms ensure adaptive and responsive inventory strategies.

Table 1. Key benefits associated with the use of DSS

Aspect	Benefit	Impact
Data-Driven Decision Making	Comprehensive insights through data integration and analysis	Enhanced operational efficiency with real-time, accurate information
Optimized Routing and Scheduling	Efficient logistics planning, reducing costs and delivery times	Improved overall effectiveness of the supply chain
Inventory Management and Demand Planning	Precise demand forecasting and optimized inventory levels	Effective resource allocation, preventing overstock or stockouts
Resource Utilization and Allocation	Efficient workload distribution, enhancing productivity	Optimal resource utilization with minimized bottlenecks
Scenario Analysis and What-If Modeling	Simulation of different scenarios for strategic decision-making	Proactive response to potential outcomes, risk identification
Improved Collaboration and Communication	Facilitation of communication and collaboration	Alignment of decisions with organizational goals, cohesive supply chain
Real-Time Monitoring and Visibility	Immediate decision-making based on real-time data	Quick adjustments to emerging issues or opportunities, enhanced visibility
Cost Reduction and Efficiency Gains	Identification of cost-saving opportunities	Lower costs, increased efficiency, positive impact on financial performance

Adaptability to Changing Conditions	Insights into changing market conditions and external factors	Proactive response to evolving circumstances, alignment with changing conditions
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AI's role in Route Optimization in Logistics involves analyzing diverse data, including traffic patterns, weather conditions, and order characteristics, to optimize delivery routes. Intelligent decision-making in logistics dynamically adjusts delivery routes for maximum efficiency, reducing transportation costs and ensuring timely deliveries. AI-driven algorithms adapt to real-time conditions, optimizing the entire logistics network.

In Supplier Relationship Management, AI assesses supplier performance, market conditions, and external risks to inform decisions. Intelligent decision-making in supplier management involves identifying optimal suppliers, negotiating contracts, and managing risks effectively. AI contributes to strategic sourcing decisions and ensures a resilient supplier network (Burger 2024). Predictive Maintenance in Manufacturing utilizes AI to analyze equipment data and predict maintenance needs, minimizing downtime. Intelligent decision-making in manufacturing involves scheduling maintenance activities based on AI predictions, reducing unplanned downtime, and optimizing production schedules, ensuring efficient and uninterrupted manufacturing processes.

Risk Management and Mitigation employ AI to assess various risk factors, informing risk management strategies. Intelligent decision-making in risk management involves identifying potential disruptions and implementing proactive measures to mitigate risks. AI-driven insights enable SCM professionals to anticipate and navigate uncertainties effectively. Order Fulfillment and Customer Satisfaction benefit from AI optimizing order fulfillment processes. Intelligent decision-making in order fulfillment ensures timely and accurate deliveries, contributing to enhanced customer satisfaction. AI-driven insights enable SCM to balance cost-effectiveness with customer service levels. DSS play a crucial role in optimizing logistics and resource allocation within SCM, Table 1. Here are key benefits associated with the use of DSS in these domains:

In summary, the benefits of DSS in optimizing logistics and resource allocation lie in their ability to enhance decision-making processes, improve efficiency, and contribute to the overall agility and effectiveness of the supply chain.

3. Methods

This research employs a qualitative, secondary data analysis approach to evaluate the role of AI in Supply Chain Management. The study relies on a comprehensive review of existing literature, case studies, and industry reports. By synthesizing qualitative data from these sources, the research aims to uncover insights into the benefits, challenges, and applications of AI in SCM. The qualitative approach is suited for exploring the complex and context-dependent nature of AI adoption and its impact on operational performance. This method provides an in-depth understanding of the factors influencing AI implementation, organizational readiness, and the experiences of companies that have integrated AI into their supply chain processes.

4. Data Collection

Data is sourced from:

Academic Journals: Articles focused on AI applications in supply chains, including topics like predictive analytics, demand forecasting, and inventory management.

Industry Reports: Insights from leading industry reports, white papers, and case studies documenting AI integration in organizations like Amazon, Walmart, and UPS.

Conference Proceedings: Papers and presentations from supply chain and AI-related conferences that highlight recent innovations and challenges faced by organizations in adopting AI technologies.

The findings from these sources were analyzed thematically to identify key trends, challenges, and best practices in AI adoption across the supply chain sector.

5. Results and Discussion

This section presents the outcomes of integrating AI and Information Systems within Supply Chain Management, focusing on their collaborative impact on data accuracy, visibility, and supply chain interconnectedness. It also

outlines proposed improvements and practical strategies for overcoming integration challenges, particularly in the areas of workforce readiness and system interoperability. Chen et al. (2020) guide our exploration into the collaborative interplay of AI and information systems, highlighting their joint role in elevating data accuracy and visibility within SCM. Practical examples, such as Bosch's effective implementation, showcase the tangible outcomes of this collaboration. The following paragraphs delve into the collaborative efforts between AI and information systems to enhance data accuracy and visibility:

The collaboration significantly enhances data quality within SCM through processes like data integration and cleansing, automated data validation, predictive analytics for data quality, real-time monitoring and correction, enhanced data matching and deduplication, semantic understanding and contextual analysis, feedback loops for continuous improvement, and user-friendly data governance.

Real-Time Visibility into Supply Chain Processes:

The transformative aspect of SCM lies in the real-time visibility facilitated by the collaboration between AI and information systems. The following paragraphs break down how this collaboration enhances real-time visibility into supply chain processes:

AI and Information Systems Collaboration for Real-Time Visibility

This collaboration utilizes AI algorithms to process data from IoT sensors, enabling real-time insights into the physical movement and conditions of goods. Predictive analytics for shipment tracking, dynamic inventory tracking, supplier and production monitoring, demand sensing, automated alerts and notifications, real-time data visualization dashboards, machine learning for continuous improvement, and cross-functional collaboration platforms contribute to a comprehensive and real-time understanding of supply chain processes.

Interconnected Supply Chain

Li and Zhang's (2019) scholarly work further expands our understanding of interconnected supply chains facilitated by AI-driven logistics and information systems. The success story of Alibaba demonstrates seamless coordination and enhanced efficiency, providing a tangible example of collaborative integration. The following paragraphs detail how this collaboration enhances connectivity and responsiveness within the supply chain:

AI and Information Systems Collaboration for Interconnected Supply Chain

The integration of AI and information systems creates a more connected and responsive supply chain ecosystem through interconnected data exchange, supply chain visibility platforms, automated decision-making workflows, predictive analytics for proactive planning, real-time collaboration tools, dynamic inventory optimization, adaptive logistics networks, responsive production planning, and intelligent risk management.

The successful integration of AI and information systems has resulted in notable improvements in efficiency across various aspects of SCM. Real-world examples, including demand forecasting, dynamic routing, inventory optimization, predictive maintenance, supplier performance management, real-time visibility and automated order processing, showcase the positive impact of this integration on efficiency. In summary, the collaborative relationship between AI and information systems in SCM creates a synergistic environment where AI-driven capabilities enhance data quality, real-time visibility, and overall efficiency. The integration leads to a connected and responsive supply chain ecosystem, revolutionizing how businesses manage their operations and adapt to evolving market dynamics.

The challenges and considerations associated with adopting AI and information systems in SCM, can be divided into two main key hurdles: Data Security, System Integration (Kim, Y. et al. 2018). The exploration offers strategic insights and solutions for overcoming these challenges.

Data Security

Addressing concerns related to the security of sensitive supply chain data is crucial for the successful integration of AI and information systems in SCM. The vulnerability is highlighted by multiple data breaches. The strategies and measures to enhance data security include encryption of data, access control and authentication, secure cloud storage,

data resilience and backups, secure APIs and integrations, continuous monitoring and auditing, data masking and anonymization, employee training and awareness, incident response plans, and regulatory compliance.

System Integration

Integrating AI and information systems with existing SCM infrastructure presents challenges such as legacy system compatibility, data silos, and fragmentation. The challenges such as legacy system compatibility, data silos, data quality and standardization, lack of skill sets, change management resistance, cost and resource constraints, security concerns, interoperability issues, scalability concerns, and ethical and regulatory compliance.

5.1 Proposed Improvements

In essence, this section guides organizations in navigating the complexities of integrating AI and information systems in SCM by addressing data security concerns, providing solutions for system integration challenges, and outlining strategies for achieving seamless interoperability. The comprehensive approach aims to pave the way for a successful and resilient integration of advanced technologies into supply chain processes. By implementing these strategies, organizations can create an interoperable SCM ecosystem where AI and information systems seamlessly collaborate, enhancing overall effectiveness and responsiveness to dynamic supply chain demands.

Nguyen et al. (2017) guide our exploration of workforce readiness, stressing the significance of preparing the workforce for technological integration. Amazon's initiatives in this domain, as an example, highlight the pivotal role of training programs in harmonizing human and technological capabilities.

To prepare the workforce for the integration of advanced technologies, particularly AI and information systems, a thorough skills assessment is essential. This involves analyzing the existing skill set within the workforce to identify gaps related to AI, data analytics, and technology. The insights from this assessment inform the design of customized training programs tailored to address specific needs.

These training programs should be comprehensive, covering AI fundamentals, data analytics, system integration, and the specific tools or platforms used in the SCM context. To enhance practical skills and build confidence, hands-on workshops and practical exercises should be incorporated into the training format, allowing employees to apply theoretical knowledge in real-world scenarios. Promoting cross-functional collaboration and knowledge sharing is crucial. This initiative encourages interactions between employees from different departments, fostering a holistic understanding of how AI and information systems impact various aspects of SCM. Additionally, change management training should be included to help employees adapt to the changes brought about by the integration of advanced technologies, addressing concerns related to job roles and responsibilities.

Fostering a continuous learning culture is fundamental. This involves encouraging employees to pursue certifications, attend webinars, and engage in ongoing professional development. Recognizing and rewarding a commitment to learning reinforces the importance of staying updated in the rapidly evolving technological landscape.

Diversity and inclusion training should also be integrated to ensure that all employees, regardless of background, feel included and valued in the evolving technological landscape. Leadership development programs are essential to equip managers and team leaders with the skills to lead teams in an environment that integrates advanced technologies.

Providing easy access to learning resources, including online platforms, relevant books, articles, and tutorials, is crucial for enabling employees to stay informed. Implementing feedback mechanisms for continuous improvement allows employees to provide insights on the effectiveness of training programs, which can be used to refine and enhance future initiatives.

Mentorship programs pairing experienced employees with those newer to AI and information systems facilitate knowledge transfer and provide guidance in a supportive environment. Integrating simulation and gamification

elements into training enhances engagement and retention by creating interactive scenarios that simulate real-world challenges in the SCM context.

Recognition and rewards play a vital role in motivating employees. Acknowledging achievements in acquiring new skills or implementing innovative solutions fosters a positive and motivated workforce. Establishing partnerships with educational institutions and collaborating on educational programs can further bridge the gap between academic knowledge and practical application.

Clear communication throughout the process is essential. Communicate the purpose and benefits of workforce readiness programs transparently, addressing any concerns consistently. By implementing these strategies, organizations can cultivate a workforce that is not only technically skilled but also possesses the adaptability and collaborative mindset necessary for success in the evolving landscape of SCM.

Implementing effective training programs and skill development initiatives is crucial to prepare the workforce, table 2, for the integration of advanced technologies, particularly AI and information systems, in the realm of SCM. Bellow is a detailed approach to designing and implementing these initiatives:

Table 2. Steps to integration of advanced technologies

Step	Action
Skills Assessment and Gap Analysis	Conduct a comprehensive skills assessment to identify existing skills within the workforce. Perform a gap analysis to pinpoint areas where skills are lacking, specifically focusing on AI, data analytics, and technology-related competencies.
Customized Training Curriculum	Design a tailored training curriculum based on the identified skill gaps and organizational objectives. Include modules covering AI fundamentals, data analytics, system integration, and relevant tools or platforms used in SCM.
Hands-on Workshops and Practical Exercises	Incorporate hands-on workshops and practical exercises to provide employees with real-world experience. Create scenarios that mimic SCM challenges, allowing participants to apply theoretical knowledge in practical situations.
Cross-functional Collaboration	Promote cross-functional collaboration by organizing sessions that encourage interaction between employees from different departments. Highlight the interconnected nature of SCM processes and the role of advanced technologies in fostering collaboration.
Change Management Training	Integrate change management training to help employees adapt to the evolving technological landscape. Address concerns related to job roles and responsibilities, emphasizing the benefits and opportunities that come with the integration of advanced technologies.
Continuous Learning Culture	Foster a continuous learning culture within the organization by encouraging employees to pursue ongoing education. Provide access to online courses, webinars, and other learning resources to support continuous skill development.
Leadership Development Programs	Implement leadership development programs to equip managers and team leaders with the skills necessary to lead teams in a technology-

	driven SCM environment. Emphasize the role of leadership in facilitating a smooth transition and encouraging innovation.
Diversity and Inclusion Training	Integrate diversity and inclusion training into the overall program to ensure that all employees feel included and valued. Emphasize the importance of diverse perspectives in driving innovation and problem-solving.
Access to Learning Resources	Provide easy access to learning resources, including online platforms, books, articles, and tutorials. Support employees in staying informed about the latest advancements in AI and information systems relevant to SCM.
Feedback Mechanisms	Establish feedback mechanisms to gather insights on the effectiveness of training programs. Use feedback to continually refine and improve training initiatives, ensuring they remain aligned with organizational goals.
Mentorship Programs	Implement mentorship programs pairing experienced employees with those newer to AI and information systems. Facilitate knowledge transfer, provide guidance, and create a supportive environment for continuous learning.
Simulation and Gamification	Incorporate simulation and gamification elements into training to enhance engagement. Create interactive scenarios that simulate real-world SCM challenges, encouraging active participation and knowledge retention.
Recognition and Rewards	Recognize and reward employees who actively contribute to the integration process and demonstrate continuous learning. Establish a culture where achievements in acquiring new skills are celebrated and acknowledged.
Collaboration with Educational Institutions	Establish partnerships with educational institutions to align training programs with academic curricula. Explore opportunities for internships, co-op programs, or joint initiatives that bridge the gap between academic knowledge and practical application.
Clear Communication Strategy	Communicate the purpose, benefits, and expectations of training programs clearly to all employees. Address any concerns transparently, emphasizing the organization's commitment to supporting workforce development.

By following this comprehensive approach, organizations can build a workforce that is not only proficient in the technical aspects of AI and information systems but also adaptive, collaborative, and well-prepared for the evolving landscape of SCM.

5.2 Validation

As this study adopts a conceptual and exploratory approach, immediate numerical or statistical validation is not applicable. However, future validation opportunities exist through application of the proposed AI and Information Systems integration framework in real-world, high-stakes environments. One particularly relevant and impactful context is the organ transplantation supply chain in Morocco.

This supply chain presents a critical and time-sensitive challenge, characterized by fragmented coordination between hospitals, inconsistent data flows, and limited digital infrastructure. These systemic issues often lead to delays,

inefficiencies, and in some cases, missed transplant opportunities. The integration of AI and information systems—as proposed in this study—has the potential to significantly improve operational efficiency through enhanced data accuracy, real-time tracking, predictive analytics, and intelligent decision-making.

Validating the proposed model within this healthcare context would not only test its practical applicability but also demonstrate its broader societal value. It would provide a compelling case for policymakers, health system planners, and technology developers to invest in digital transformation initiatives that align technological innovation with public health outcomes.

Such future work could include a mixed-methods evaluation, involving system audits, stakeholder interviews, and scenario-based simulations to assess the potential gains in efficiency, coordination, and patient outcomes. Ultimately, this future validation pathway emphasizes the real-world relevance and transformative potential of AI-integrated supply chain frameworks in life-critical domains

6. Conclusion

This paper has explored the transformative role of AI and information systems in supply chain management (SCM), emphasizing their potential to enhance operational efficiency, risk management, and customer satisfaction. Key findings include:

Predictive analytics improves forecast accuracy and helps reduce inventory costs.

AI-driven demand forecasting boosts operational efficiency and elevates customer satisfaction.

Decision Support Systems (DSS) optimize logistics and resource allocation.

The integration of AI and information systems creates a more connected, responsive, and efficient supply chain ecosystem, as demonstrated by several real-world case studies.

However, to fully unlock the potential of AI in SCM, certain challenges must be addressed, particularly data security, system integration, and workforce readiness. One of the most crucial aspects for success is achieving seamless interoperability between AI and information systems. This can be accomplished through strategies like adopting industry standards, utilizing APIs, implementing middleware solutions, harmonizing data, using Master Data Management (MDM) practices, prioritizing real-time data exchange, fostering collaborative platforms, designing scalable architectures, and continuous monitoring and testing. Collaboration with technology providers will also be critical for ensuring that these integrations function effectively across all levels of the supply chain.

Policy and Managerial Implications

For Policymakers: Establish frameworks to support AI adoption in SCM, including funding for workforce training and incentives for technology integration.

For Industry Leaders: Invest in AI-driven technologies and prioritize workforce readiness through targeted training programs and skill development initiatives.

For Researchers: Conduct cross-industry comparisons to identify best practices and explore the ethical implications of AI in SCM.

As part of future research, validation of the proposed model could be conducted through its application in the organ transplantation supply chain in Morocco. This context presents unique challenges related to fragmentation, data sharing, and timely decision-making, which could be addressed by integrating AI and information systems. A real-world study would not only validate the proposed framework but also provide valuable insights into its impact on operational efficiency, responsiveness, and patient outcomes.

By tackling these challenges and leveraging the opportunities presented by AI, organizations can build a more intelligent, adaptive, and interconnected supply chain ecosystem that is equipped to meet the demands of modern markets.

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Biography

Sabrina Guetibi is a pedagogical director and full-time academic at the Superior Institution of Sciences and Techniques, Associate College of Cardiff Metropolitan University. With a strong background in operations management, supply chain management, and management information systems, she has made notable contributions to healthcare systems research, publishing extensively on hospital information systems and healthcare improvement. Dr. Sabrina serves as an associate editor and journal reviewer and is actively involved in research exploring the integration of artificial intelligence in healthcare. Her research has addressed AI adoption barriers within healthcare sectors. As a speaker at various conferences, Sabrina shares insights on the application of AI to enhance operational efficiency in healthcare. She is also the host of Moroccan Mama Life, a podcast that focuses on the intersections of motherhood, career, and family life. Sabrina's academic focus is on improving system interoperability and enhancing healthcare supply chain management through the use of AI.