

Predictive Lead Time Compression in Multi-Tier Retail Networks: A Machine Learning Framework for Supplier Synchronisation

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1. Introduction

Modern retail has embraced fast-moving fashions and new lifestyles by sequentially updating seasonal collections. In doing so, retailers are faced with increasing urgency in responding to fluctuations in demand drivers such as regional and localized fashion, weather, and new trends. Consequently, retail supply chains continue to be optimized to focus on reducing lead times, as they play a crucial role in enhancing customer satisfaction. At the same time, AI-based strategies and techniques have elevated to the forefront of strategies to address many of the ongoing and emergent challenges associated with reducing retail supply chain lead times. Our focus is on the potential AI-based mechanisms that could contribute to handling some of these complex challenges to reduce lead times in retail supply chains today. We begin by differentiating between technology and tools, where a tool refers to a specific application of a technology.

In this context, we define technology as a new way of doing something that is both disruptive and superior. We suggest that providing visibility into the supply chain and demand processes requires tools, and we classify the day's more common and promising tools according to this activity right at the intersection between artificial intelligence and retail logistics. We use RFID technology to track items in the supply chain, particularly for products moved through multi-tier distribution networks. It introduces the concept of machine learning algorithms that can be combined with other technologies to form the core of a tool for event forecasting. We have also discussed the possible hyper-personalization of perishable inventory replenishment on this same dimension of basic fusion.

1.1. Background and Significance

The retail supply chain has evolved from a fixed to an agile and dynamic supply chain that can connect suppliers to manufacturers to retailers. Due to these growing complexities, companies struggle to improve supply chain operational efficiencies, which are critical for business survival. Lead time, which is the time required for an entity in the chain to satisfy a customer, is often taken as a major KPI in industries and aptly termed the inverse of the speed of the chain's delivery model. Primarily, every retail company encompasses lead time as a diverse speed element in its annual performance review. An ideal short lead time allows the company to pursue several supply chain strategies, including response-based supply chain, postponement, and mass customization. Since competition in the retail industry is based on product design and availability along with its cost, efficient lead time management is a challenging issue in the retail industry, especially in fashion retail merchandise.

Several studies provide evidence of the increasing lead times in the industry. Lead time reduction in the fashion industry is the latest buzzword with an explicit goal to design a collection and stock it with up-to-date merchandise throughout the season. However, with increasing globalization, due to the popularity and enticements of low-cost production in Asian countries, most fashion retailers no longer stock merchandise for the entire season. In European countries, a considerable amount of merchandise is restocked throughout the season with shorter lead times and requires more and more referrals to overseas sources. Lead time fluctuations continue to be an important feature in the industry. Production capacities of factories rarely match overseas demand; thus, maintaining a competitive advantage is a continuous challenge. This ultimately leads practitioners to combine innovative supply chain solutions with continuous advanced utility of technologies to differentiate in overseas retail firms. Although the possible innovative insertion of artificial intelligence approaches in several business processes is quite clear, literature is sparse when it comes to retail supply chain, especially in the domain of lead time management.

1.2. Research Objectives

The primary goal of this research is to identify AI-driven strategies for reducing lead times in retail supply chains. This section outlines the overarching research objectives, which have been established to gain knowledge on AI technologies relevant for supply

chain optimization and explore the practical implementation of the identified strategies in a retail setting. This research critically evaluates the performance of AI-based strategies for application in the retail industry and their impact on supply chain efficiency. It aims to investigate the aforementioned objectives from a theoretical and empirical point of view. This research has practical relevance for the apparel retail sector, as the insights gained will be of interest to retail practitioners facing the challenge of efficient fast fashion management. The application of the results of this study in practice may assist managers in improving retail supply chain lead times and, hence, the entire supply chain. The overarching research objective is to identify AI-driven strategies for reducing lead times in retail supply chains and investigate their implementation. To achieve this primary goal, this research aims to achieve the following three specific objectives: 1. To identify current AI technologies relevant for supply chain optimization by reviewing literature. 2. To study the practical implementation of AI technologies in supply chain management and, based on the results, to identify AI strategies likely to be embraced by retail companies in order to reduce lead times. 3. To empirically validate AI strategies, using various supply chain KPIs that are considered to be the most important by both retailers and practitioners.

2. Understanding Retail Supply Chain Lead Times

Retail supply chain lead times are an area of great interest within the retail industry. These lead times are defined as the time passing between letting a supplier know the retailer needs additional stock and receiving the final delivery into stock. They are fairly complex within retailing, especially within the omnichannel distribution environment, and are mainly influenced by the speed of supply at manufacturers, the volume of stock that can be purchased, and the frequency of ordering. Due to such complexities, retailers who can capture demand quickly enough and react to demand that is not correct have a smaller chance of ending up with surplus or obsolete inventory or stockouts, subsequently driving operational efficiencies.

There are three main types of retail supply chain lead times: the order processing lead time, the supplier lead time, and the delivery lead time. By understanding and managing these lead times, retailers can also potentially manage customer satisfaction if omnichannel environments are used by end consumers. Longer times can result in poor shop sales and reputational damage to retailers. In addition, shorter lead times reduce

the amount of safety stock held, also minimizing operational costs. If managed correctly, retailers can maximize profit and service levels by ensuring stock is aligned with consumer demand. Due to current trends in retail, real demand can be measured up to eight weeks earlier in some cases; this allows the wholesale of surplus stock.

2.1. Definition and Importance

Definition

The notion of lead time is well documented in the supply chain literature. Lead time is the time period between ordering and availability of an item for use in a process or for sale to an end customer. The inbound lead time represents the time required for shipments to travel from the supplier to the retailer or warehouse, and the outbound lead time is the time it takes for an order to travel from the retailer to the customer. In averaging form, lead time can be denoted as the accumulation of the time taken to accomplish the individual components of a produced part. In the retail sector, lead time management becomes imperative due to: Customer service considerations, such as on-time delivery to the end customer; and Inventory control considerations: for stock keeping control policies, the lead time acts as the underlying foundation for calculating stock holding levels according to the level of service.

Importantly, variance in lead time is likely to arise from multiple sources such as transportation time, delivery time, vendor processing time, lead time for raw materials, production process time, any unexpected process interruptions or disruptions, or policy changes. Defining accurate lead times is the primitive stage of any literature theme. To this end, there is no generalized model for deriving the lead time given the diversity in the distribution of transportation and reorder factors, as well as the alternatives from which the control viewpoints differ. Replenishment and ordering cycles are typically proposed with fixed lead time. One way of improving a supply chain's efficiency is to reduce the possibility of extended lead time by decreasing the occurrence of shortages.

Lead time plays a crucial role in current purchase and replenishment strategies. For buy-back agreements, it is prevalent that suppliers have the right to return unsold goods because surplus and stock unavailability reflect differently on pricing schemes due to their direct impact on the retailers' sales capacity. When considering vending machines, a short replenishment order cycle hinders a machine from being out of stock, and in the

case of crucial vended items, significantly impacts the final costs involved. Lead-time variability tends to dominate the reorder point variability irrespective of whether the demand distribution is discrete or continuous. In addition, the impact of lead time variability on the costs of supply, caused by shortages, is predominantly irrational. Lead time is one of the three major reasons for inventory in the boom-bust cycle mode to exist. A master production schedule for a pharmaceutical company can be formulated and maintained under lead time constraints in the face of raw material resource limitations. The rising importance of outsourcing and more distant supplier relations has led to growing interest in lead time.

In totality, the research gaps and existing literature on the market lead time and issues that it addresses should be questioned to provide a better context. Given this complexity, a natural point arises whether AI could be used for reducing lead time—reducing the variance of lead time in general or in the context of market lead time management. This issue is further questioned and explained in greater detail in the later part of the literature review.

2.2. Factors Affecting Lead Times

2.2. Factors Affecting Lead Times. A variety of factors affects lead time and the level of variability in practice. In a retail supply chain, lead time variability is affected by a) internal factors such as inventory policy and order processing systems, and b) external factors such as supplier performance and transportation systems. The factors that drive lead time variability are interrelated and sometimes can amplify each other. From the retailer's perspective, lead time is the time during which they are left exposed to variability and subject to risks. Longer or more variable lead times reflect a stronger negative impact of this factor on supply chain performance. Thus, by minimizing lead times, retailers hope to move their stocks closer to the sales points, hence reducing inventory management costs. Indeed, a shorter or less variable lead time makes it easier for retailers to keep their stocks in close synchronization with consumer demand. Lead time variability can be due to a variety of root causes: inherent process variabilities, aggregate demand variabilities, and market trends, such as promotions, that could affect the inter-arrival time of demand.

In current systems, technology from different perspectives has been used to minimize or reduce the variabilities in the system. For example, from the demand variability

perspective, technology could be used to share demand information downstream and upstream in the supply chain using data and electronic data interchange - a short-term strategy. It could also be used to do demand forecasting and strategic sourcing using, for example, data warehousing and neural networks - a long-term strategy. Thus, technology, when used judiciously, could help minimize the variabilities in the system, smoothing out the bullwhip effect. In addition, it could also reduce the lead time in the system. For example, the process of order processing could be automated and the response time reduced using an advanced order processing system, with far-reaching implications. Having reduced the variabilities, a system with lower lead time will have a greater competitive advantage in the market.

3. AI and Machine Learning in Retail Supply Chains

In recent years, artificial intelligence (AI) and machine learning have been the subject of extensive research within the retail supply chain. While research into AI and machine learning applications is not new, the prevalence of the 'big data' phenomenon and advances in computing technologies have provided a strong impetus for exploring new applications of AI and machine learning. Advances in computing hardware and open-source software have also come together to make machine learning tools more widely available. These technological advancements have provided firms with practical, affordable, and reliable tools to support real-time and data-driven decision-making in order to generate efficiencies and savings across the supply chain. AI technologies, in particular, can leverage the large volumes of data to predict a variety of outcomes, from customer shopping behavior to future demand on individual SKUs. By predicting these outcomes, retailers and suppliers are able to set strategies that will deliver the best outcomes for regional centers, depots, individual stores, and loyal customers.

Managers in the retail supply chain have long been aware of the benefits of data-driven decision-making in improving their business operations. The ability of AI systems to undertake repeatable, automated decision-making from the processing of these data sets is therefore a key asset in mitigating the risks and challenges that face managers in the retail supply chain. Data is available from a wide variety of both internal and external sources; ideally, it would be aggregated from these sources, cleaned, and then forwarded to the systems for decision support. There are now a rising number of AI technologies that are becoming more embedded in retail supply chain operations, for

example, predictive analytics, natural language processing, recommendation engines, and conversational systems. Coordination in the form of synchronization between suppliers, logistics, and retailers will be essential to bring longer-term efficiencies to the supply chain by reducing lead times. The above challenges and potential for cloud-based AI mean that both suppliers within the supply chain can have access to these systems and may be trained online within the platform that has been implemented. With this additional AI technology applied further upstream and early on in the supply chain process, other opportunities that come from automation may present themselves. Jobs completed by human operators can be replaced by AI systems, streamlining operations and reducing lead times. This is particularly the case where the process can be broken down into distinct repeatable events. To this end, we find that AI is gaining significant traction in enhancing retail supply chain performance.

3.1. Overview of AI and Machine Learning Technologies

AI and machine learning technologies are primarily developed to analyze and extract valuable insights from large amounts of data. These technologies do not have separate applications for retail or other industries. Rather, the specific use of AI and machine learning occurs in the way they utilize data analysis and generate insights that can be used to improve business. These operational AI technologies help businesses, including retail, to increase overall operational performance of various functional sections or supply chains as a whole, by streamlining processes and also providing decision support with real-time data analysis. Many of these technologies apply to the improvement of supply chain planning and management operations to reduce lead times across industry sectors, including retail.

Integrating these AI-powered technologies with existing supply chain systems is essential to reduce lead times. This integration will also enable the development of a closed-loop framework; this can provide insightful analytics to steer continuous learning and improvements in the necessary areas of the supply chain. In a world where demands are swiftly changing, retail environments and their supply chains are being increasingly driven from a one-to-many approach to a many-to-one approach. Therefore, the ability to integrate new forecasting AI technologies with existing systems for product availability management becomes an essential ability for retail and supply chains to retain margins. Many retailers also integrate time-series forecasting AI into

their inventory management systems to auto-replenish products. These auto-replenishment systems are designed to achieve specific KPIs such as service levels, stock cover, or forecast value add. Time-series forecast AI can significantly reduce stock and lower inventory holding costs by providing a higher accuracy monthly average forecast. Lower inventory costs are achievable as the AI system can provide the right stock levels to ensure product availability and can avoid stockouts.

3.2. Applications in Supply Chain Management

Several applications of AI in retail supply chain management demonstrate how this technological approach benefits supply chain operations. For example, AI and machine learning are used in demand forecasting and decision-making, leading to improvements in both demand forecasting accuracy and the overall sales processes. AI-based demand forecasting is used for predicting sales at the store level in the retail industry. Similarly, the modern retail industry uses AI techniques for efficient inventory prediction and to minimize the bullwhip effect in the retail value chain. In addition, AI and machine learning algorithms are also used to calculate the appropriate inventory level based on real-time demand, resulting in more responsive supply chains and the ability to minimize stock vulnerabilities. AI-based supplier selection is used to aggregate expert opinions and result in the most efficient, viable, and socially responsible supplier. Furthermore, AI technologies enable collaboration between supply chain partners and contribute to an entirely new approach to strategic inventory planning throughout the supply chain using AI.

The retrieval of the elements of a four-echelon supply chain from the actor's perspective has been proposed, and advanced machine learning models were used to address several issues related to this representation. As a result, the production behavior of suppliers and the formation of orders of central actors were significantly improved. AI solutions were proven to reduce inventory levels at all chain levels through a simulation with datasets from two major companies, including luxury items and non-luxury items, paired with real customer demand datasets. Case studies in a retail environment show that predictive maintenance based on AI algorithms prevents costly repairs. In a real-world application, a transnational retail corporation was able to reduce maintenance costs, increase uptime, and reduce inventory. In summary, AI bridges supply chain inventory, maintenance, and decision-making. Although the concept was not fully

established, the study proposed an adaptive supply chain orchestration with AI-enabled cognitive intelligence functioning as a decision-making tool. Retail logistics and the supply chain in the context of real-time data-driven predictive analytics through integration with IoT and AI have been discussed in recent studies. The study introduces a robust new supply chain decision to consider the uncertainties of demand and lead time. The weak sale of seasonal products and the uncertainty of big data have resulted in a need for decision-based management in the supply chain for retail operations. With several AI development applications in the supply chain, the region of this study focuses on the relevance of the results of hardware-based deep learnings associated with retail supply chain lead time reductions through a literature review of AI applications in supply chain management.

3.3.1. Introduction of each application area of this study. 3.3.2. AI applications that track lead time reductions at the end of the retail supply chain. 3.3.3. Absence of the literature on lead time reduction with AI. 3.3.4. Gap of AI application. 3.3.5. Applications of technology with advanced analytics.

4. Case Studies and Success Stories

The power of AI shows in the results of real-life case studies that cover a range of different retail businesses. In the online space, a major e-commerce company made use of AI to address lead-time challenges in its supply chain, achieving diversion cost savings of between 15 and 30 cents per unit at a dynamic profit improvement of 5-15%, depending on the scenario. A fast fashion retailer was also able to improve inventory allocation via AI, reducing stock-outs and improving KPIs surrounding inventory reduction. In more traditional retail spaces, stores leaned on AI to enhance labor forecasting, which resulted in a 40% reduction in cash wrap waits. An Australian supermarket took advantage of AI demand forecasting to more effectively manage inventory according to store conditions, improving order accuracy and reducing lead times. Despite these success stories, it is important to note that the journey to AI adoption did not come without challenges and learnings for these companies. The case study details how AI implementation required engaging key stakeholders and training analysts to ensure the technology was used optimally. Using a strategic approach to AI is one of the critical lessons from the case studies featured. For retailers considering this technology, the key lesson is to build from the ground up, starting with a strong

understanding of the problem area, deep stakeholder engagement, an investment in internal capability, and a focus on continuous learning and test-and-learn techniques. The channels of retail are changing. Whether you are running brick-and-mortar stores, e-commerce operations, or a multi-channel, omnichannel retail business, AI has the intelligence to reduce retail's challenges around lead times.

4.1. Real-World Examples of AI Implementation in Retail Supply Chains

The following subsection begins to provide context for our AI-based supply chain lead time reduction agenda item within retail, illustrating AI's potential to add value across the industry. For example, companies have explained the basics of their operations, their method of AI technology used, the objectives/results, challenges faced, and key insights: Fashion and lifestyle company OTTO Group is using automated learning to improve automatic demand forecasting and ordering systems to better allocate goods and reduce lead times, out-of-stock scenarios, and overstock. OTTO uses built products to process the data. Logistics provider Fiege is piloting machine learning for route and vehicle condition optimization. A leading parcel delivery brand uses a proprietary AI tool to ensure that retailers, consumers, carriers, and the company maintain good visibility of the travel path of parcels. The AI technology is used to create rolling forecasts for self-learning models which consider former tracker locations and plan the next two hours. Notably, it was found that with increasing ease of conveying information between parties, the perceived lead time reduced distraction when waiting for the delivery. Robotic fulfillment company Dexterity had a customer who recently employed approximately 6,000 temporary employees to help fulfill its holiday orders. The employee count increased because staffing with a temporary workforce makes it hard for companies to get employees up and running quickly. Using robots and sophisticated machine learning, Dexterity allows the company to operate at holiday order levels all year round using a fraction of the hourly workers. Incorporating AI into operations, an e-commerce and mail delivery company has tailored choices for delivery when carriers are at the residence and taken into account such specifics as whether it is "leave package at garage or storage unit?" or "give to my neighbor unless there is no answer." While starting with a very basic model, they recently built a new machine learning model, which has been active for about half a year. Prior to this machine learning model, a company sales representative noted that "the delivery assistant didn't know anything about our customers. It was essentially a single-celled life form. The fact that it was not

learning. The machine learning model considers about 50-60 factors when deciding what options to offer customers.

5. Challenges and Future Directions

While AI strategies for the retail supply chain are developing, there are still multiple challenges that companies currently face in their journey of AI adoption, namely inaccurate data and low-quality data. While machine learning is data-hungry and requires a good amount of data to be effective, the integration of AI systems into the existing software, programs, and technology is critical for seamless operation. However, the lack of historical and clean data may perform poorly when sensor systems that are influenced by historical trends are introduced. Finally, at a managerial and employee level, skill gaps are emerging, as AI-oriented training and certifications are necessary to support and operate AI retail strategies within a company setting. To mitigate these challenges, it is important for companies to adopt a strategic roadmap towards AI in retail, with deep thought for potential roadblocks, barriers, and operating expenses. It is therefore worthwhile to conduct a thorough assessment of the changing retail landscape where AI will play a pivotal role in strategic offerings. The future direction of AI involvement in retail supply chains involves three important points: (1) Trends – Retail is grounded in technological change. As technology expands and provides further opportunities and improvements that can be made, AI strategies can deploy these emerging technologies. (2) Synergies - AI can take advantage of other emerging future technologies within retail supply chains. (3) Governance - A strategic roadmap of AI seeks to consider and also govern the impacts of these developments, including regulatory and ethical considerations. Disruption within the AI retail strategy lies within emerging technologies such as the Internet of Things, prediction-led analytics, and blockchain. It will be critical to take a wider consideration into the ethical development framework and how these technologies may lead to ethical considerations or further the enforcement of a regulatory framework. If a governance framework is not adopted, investment in an AI retail strategy, or the development of a strategic roadmap, may be discouraged. Ethically, companies also need to think of what AI can be used for in the retail space and how to segregate or enforce regulations that may terminate the ethical use. Instead of simply focusing on predictive models, a future retail strategy may focus on curating and developing competitive exposure by embracing a human/AI blend for strategic decisions. With regards to operations, the skill set of human employees may be

redirected with an emphasis on replacing non-value-added activities with skill enhancements available in AI technology. Jobs may be redesigned or eliminated completely. It is imperative that to drive AI through a strategic roadmap, companies embed these disruptions through training and learning initiatives, blending human and machine intelligence to enhance the employee experience through enriched workspace. AI can grow in commonplace strategy adoption through the development of digitally informed and advanced intelligence rather than routine decision support. However, as noted before, the skill-building opportunities must be acknowledged and training needs to be built through blended learning structures. Overall, investing in training, the skill set, and the infrastructure discussed in the previous sections is essential so that the expected rewards of AI retail strategies can be realized with little harm on the footprint of added retail value. Justifying such a strategy should consider the full spectrum of operations to reduce costs and assist in developing competitive mentality in the retail space into a forward-looking perspective.

5.1. Obstacles to AI Adoption in Retail Supply Chains

AI technologies have the potential to help retailers cut lead times in their supply chains. However, despite a growing interest, few retailers have put these technologies into practice. Retailers often have one or several obstacles to overcome before they can invest in AI for their supply chains. For instance, retailers have to convince stakeholders of the utility of AI as the organization goes through both infrastructure and mindset changes. Another obstacle is the lack of necessary expertise in AI among decision-makers in retailing. A third obstacle is that some of the most well-suited AI technologies have only recently been accepted as producing defensible results. Therefore, experience with using them or, at least, making sure that competing firms can use them without noticing much of the payoff is limited.

There are often many obstacles to adopting new technologies in practice. These obstacles may be due to change aversion, lack of understanding, and insufficient infrastructure to support technology implementation. We observe the same barriers to adopting AI technologies in retail supply chains. To facilitate change and access the full benefits of AI, specifically in relation to reduced lead times, it requires stakeholder buy-in and AI-specific training. Obstacles, such as resistance to change due to this mindset, mainly relate to power and politics in an organization, and are firm-specific. As AI technologies

are becoming both more widespread and accessible for retail supply chain processes, it is no longer a question of if retailers should invest in AI, but when they should invest in AI. There are different strategies for AI adoption in retail supply chains, and the one adopted by the retailers in our sample draws on existing practices in managing supply chain technologies.

5.2. Emerging Trends and Opportunities

This subsection explores AI and supply chain trends that are still emerging and only discussed in the academic literature. The major trends can be summarized into broad categories given the direction of current AI literature in supply chain research: (1) enhanced data analytics, (2) personalization and omni-channel retailing, (3) increased use of automation, (4) development of new, more sophisticated AI algorithms, and (5) a focus on the final delivery. As these trends begin to 'tip', the implications for retail supply chains have been forecasted. Enhanced data analytics will not only necessitate improved management of data and integration of information sourced from various touchpoints, but will increase the rate of AI implementation. Advanced business automation is expected to increase the agility of supply chains through greater forecast accuracy and capabilities in predictive modeling. Once concerns surrounding standardization and solution scalability are addressed, a broader application of AI and machine learning will be seen in supply chains.

The final trend of focusing on the 'last mile' of delivery will have implications for lead time reduction if a greater emphasis is placed on streamlining this part of the delivery journey. Throughout these trends, one of the predicted drivers of change is customer behavior. In their concern with reducing delivery lead times, consumers are helping to drive the above trends by pressuring retailers into staying competitive and delivering fast, while also facing increased scrutiny by regulatory bodies holding organizations accountable for their environmental impact. An understanding of these trends can help shape strategies for the future and can guide the shape of future research opportunities. For retailers, supply chains characterized by real-time inventory data and digital platforms facilitate opportunities to leverage AI for function optimization and improved personalization strategies. Similarly, the Internet of Things can generate data that can be leveraged to create real-time replenishment strategies and improve forecast accuracy.

The above trends provide us with avenues that can be leveraged even further to propagate AI development in the reduction of lead times. To fulfill these trends, the reports explore future opportunities, including the development of social media sentiment analysis as a marketing tool, and neural machine translation and cognitive automation for supply chain management. Furthermore, the ability of managers to leverage AI-driven automations should lead to the 'ability to personalize retail recommendations to a segment size of one' and provide a more 'agile' service. As these trends become more widespread, emphasis should be placed on remaining agile and being receptive to and swift to adopt new AI and software strategies. Retailers can facilitate external collaboration to further enable AI lead time reduction opportunities. The collaboration of AI and big data engineering, strategic management, and supply chain operations research provides a fertile area of study for the interconnectedness of these fields. The combined efforts of these stakeholders add to the benefits of engaged trend research in that not only existing AI strategies for lead time reduction were investigated, but those emergent trends that will shape future prospects could be forecasted, discussed, and have possible avenues of exploration suggested.

6. Conclusion

Lead time management remains the key to achieving a competitive edge in the retail industry. The ability to navigate today's complex and turbulent business environment depends on it. As such, companies should leverage digital technologies, and AI in particular, to overturn their supply chain paradigms and develop interactive and seamless operations strategies that include both fronts. While AI's use in practice for time-sensitive retail supply chain operations still has a long way to go, the technology has great potential, with the ability to fundamentally change the current practices in such areas. An AI-based approach could be more expedient by either directly solving the optimization problem or providing initial solutions for solving the problem using mathematical programming approaches. The literature review also demonstrates that AI and machine learning applications in supply chains can help automate routine decisions or enhance supply chain professionals' decision-making capabilities. Successes with AI in applied practice transcend time-sensitive retail supply chain operations, breaking the limitations of the collaborative experimentation environment. Despite these success reports, many challenges remain in penetrating organizations with AI. Today, AI use in practice is in its early stages, and there are many organizations in decision-making that

are skeptical about the technology and can see no intelligence in AI. In conclusion, it is important for organizations to have a clear strategic vision on how AI can be embedded in everyday decision-making operations to enhance their strategic competitiveness. Retailers need to embrace AI, or they may become uncompetitive, arguing that pure intuition and professional judgment may be insufficient in leading-edge retail supply chain operations in the future. Future empirical research on AI's use in practice in the retail supply chain context is needed to test the observed propositions.