Ensemble Demand Forecasting with Exogenous Signal Integration: AI-Driven Approaches to Enhanced Retail Supply Chain Planning Accuracy

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1. Introduction to Retail Supply Chain Forecasting

Introduction Retail supply chain forecasting is crucial for effectively operating the retail supply chain and goes a long way in determining the efficiency of the operation. Efficient forecasting can tremendously influence the inventory level in the supply chain, which also impacts the profits of each partner in the retail network. Accurate supply chain forecasting also helps to enhance customer satisfaction, which further improves the profitability of the organization. Retail supply chain forecasting has been researched over the years, and all the decision-makers in the retail supply chain, from the manufacturer to the retailer, have been employing various forecasting methodologies to achieve several benefits. The traditionally used forecasting methodologies did produce some results. They undoubtedly gave us improved forecasts compared to subjective guesses. Nevertheless, they were not capable of adjusting to market changes rapidly and could not provide the expected results. For example, sometimes they came up with poor demand forecasts even when the demand had grown in previous years. Since the retail environment is quickly changing, there is a need for employing advanced technologies in forecasting to achieve optimal supply chain efficiency. Recently, many retail entities are applying advanced technology such as artificial intelligence, machine learning, and other technologies to improve forecasting accuracy in the retail supply chain. The use of machine learning in supply chain forecasting enables planners to consider the desired variables in their demand forecasting process, allowing them to achieve a high level of forecasting accuracy.

1.1. Challenges in Traditional Forecasting Methods

The traditional approach to retail supply chain forecasting and demand planning has not always taken into account the fast pace of market changes, product fashionability, or the swiftness with which consumer behavior can fluctuate. It's common for historical data to drive forecasting in supply chain and retail sectors; however, extensive use of price discounts and promotions in modern retail often makes demand-generating predictors or drivers obsolete. Consequently, even when sales volumes are fairly steady, the supply chain may suffer from excessive and obsolete stock. Most traditional quantitative methods use some form of statistical approach; however, in the modern era of big data and datafication, current statistical approaches, while useful for structured data, are less efficient with the range of data available as they can be overstressed with big data numerical methods. One further fault of traditional forecasting methods is the limitations of manual forecast tuning and intervention, along with forecasters' ability to override the system, often due to an inappropriate mindset, be it optimism or pessimism, on a perceived outcome. Secondly, manual input and maintenance, or lack thereof, may impact the quality of the data forecasts.

Human errors in manual work can exacerbate errors and discrepancies. Moreover, if a market trend changes rapidly, it is not always the case that historical data will show the signals in advance of the trend change, as these signals may be non-linear or complicated to detect. Thus, models need to be adept and flexible, capable of shifting supply chain functionalities. A new system must also be ready and capable of adapting to this new information. Furthermore, consumers have more information available to them; they are also looking for personalization and experiences. These factors result in a convoluted factor calendar, more decisions throughout the day, more relative seasonality, and more skewed and varied demand. Regulatory changes will also have reversion and 'day one' changes at a macroeconomic level. This must be addressed. This justifies the need for newer and more innovative forecasting techniques.

2. The Evolution of Artificial Intelligence in Retail

Artificial Intelligence (AI) in retail has gone through transformative changes over the years. Previously, businesses had to operate with guesswork, estimations, and experience to guide them through decision-making. With the adoption of AI, businesses now have access to the potential value represented by big data to drive their decision-

making. Historically, techniques used in AI could only address limited problems using manually engineered rules and processes that were cumbersome to maintain. As the amount of computational power increased, many promising approaches and complex models have been developed, culminating from earlier years when basic statistical methods held sway in the retail community. One of the most prevalent approaches used in AI is machine learning. So, what is machine learning? It is a subfield of AI that focuses on the development of computer programs that can access data and use it to learn for themselves. The learning process starts with observations or data, such as examples, direct experience, and instruction, in order to look for patterns in data.

A subset of machine learning is deep learning (DL). It has proven to be effective in recent years and has found its importance in predictive models. It also offers greater depth and degree of mathematical rigor in modeling and computational predictions than classical machine learning algorithms. Different from machine learning, DL models have additional layers of neural networks that enable the extraction of features from raw input. The extracted features are then passed to classifiers for decision-making. Deep learning has made a significant impact in fast-tracking analysis and has become an ideal method within AI and data in general, more specifically with predictive models. AI has been used within many areas of retail involving recommendation systems, understanding unseen events, anomaly detection on surveillance data, replenishment, route predictions, and customer service, to name just a few. Today, there is great competition among retailers to demonstrate who has the most efficient AI in their business. It is evident that significant developments have been made over the years, and important improvements are attributable to the discovery of better algorithms that outperform older released ones. This is a great revolution for companies investing in AI and forecasting information.

2.1. Machine Learning and Deep Learning Algorithms

1. Introduction The advancement in data-driven algorithms has changed the field of retail supply chain forecasting and has led to greater automation of forecasting processes. These algorithms, including machine learning and deep learning, can learn from historical data patterns to capture sales cycles, predict periodic fluctuations in demand, customer behavior, and more. Forecasting in retail fundamentally depends on customer preferences, geographical differences, and incorporates many consumer

behavioral patterns. Hence, the underlying algorithms not only need to be robust to data noise but also need to evolve over time to capture those subtle features. Therefore, traditional forecasting techniques, considering expert guidance, sales dashboards, frequent reviews, demand sensing, etc., could not be as efficient as the demand forecast that was purely driven by an individual's intelligence and experience. Due to exponentially increasing data, sales volumes, products, and various customer preferences, it becomes imperative to use quantitative techniques with self-learning capabilities to understand customer preferences and how they change over time. Following is a brief introduction to some popular machine learning and deep learning algorithms. Some other popular techniques include time series, VAR models, neural network models, multivariate adaptive regression splines, XGBoost, Random Forest, and SVM.

2.1 Machine Learning and Deep Learning Algorithms Machine Learning and Deep Learning are two sub-disciplines of Artificial Intelligence that are seen as state-of-the-art and have been gaining popularity in the retail supply chain industry. These algorithms specialize in learning the patterns underlying the given input data and making good predictions thereafter. In the context of retail demand forecasting, the data can vary from simple time-series variables such as sales, revenue, and transactions to unstructured data like customer reviews, website click-throughs, social media data, etc. ML algorithms can be classified into two types: supervised learning and unsupervised learning. The former is the case where the model learns from the training input-output data pairs; suppose X represents the features of the item, and Y is the target variable such as the demand that is to be predicted. The algorithms use X to map to Y and understand the relationship between independent variables and the target variable. Ensemble method models such as random forests, gradient boosting, XGBoost, and decision trees are some examples of SL models that are widely adopted by retail companies. Deep learning is a sub-discipline of ML algorithms that are mainly used to extract high-level complex data features by means of multiple hidden layers. These models are known to be more effective than ML models in handling unstructured data, images, sounds, and text data. In seminal work, winning solutions of various international machine learning and data mining competitions, as well as public-private data science problems, deep learning algorithms have proven to be quite effective in handling structured data with thousands or millions of attributes. The most widely used

deep learning algorithms are ANN, CNN, RNN including GRUs and LSTMs, ARIMA, and RBMs. A few other algorithms are based on the concepts of probability that include Gaussian Mixture Models, Hierarchical Mixture of Experts, and Hidden Markov Models. In general, deep learning performs well with large datasets and apparent complex structures.

3. Applications of AI in Retail Supply Chain Forecasting

To enhance forecasting in the retail supply chain, AI can be applied in several different business processes. Demand forecasting uses AI tools to predict consumer demand with high forecasting accuracy. Furthermore, demand forecasting is supported by the prediction of sales or order quantities. AI applications contribute to reducing inventory levels through improvements in stock management, demand capture, and demand prediction. Additionally, lead time forecasting benefits from AI applications in the supply chain. The four most researched areas in retail and supply chain management using AI in forecasting include integrating AI-powered forecasting models into existing supply chain management systems, which may significantly boost their accuracy.

AI models can be used to produce significantly better demand forecasts. AI prediction also reduces forecasting errors and produces the best predictions. AI and demand capture result in better forecast accuracy. Machine learning models can be applied for inventory reduction or more accurate stock management. AI can also be applied to order forecasting and reduction. Efforts have been made to predict the quantity of orders and the risk of default through various AI techniques. Moreover, an AI algorithm that can predict and classify both the quantity of orders for the next day and the date of the unsold periods will help with stock promotions and reductions through the use of Artificial Neural Networks and Long Short-Term Memory. Predictive models can be used to forecast orders and deliveries for catering services. Large amounts of data generated from various IoT devices, sensors, and equipment can be used to predict orders and deliveries. AI can be used for demand forecasting to provide an optimal solution for order planning under uncertainty, such as in multi-product, multi-period demand with lead time and price influence in the manufacturing system.

3.1. Demand Prediction

The most crucial aspect of retail supply chain forecasting is demand prediction. Predicting the number of units of a product that will be sold at some point in the future

informs inventory management, helps offload additional retail stock, and sets the stage for further supply chain planning. The rapidly fluctuating market and consumer needs are among the primary challenges of accurate demand forecasting. Most sales predictions consider factors like seasonality, the time of day, or whether the day is a holiday. AI and ML algorithms, in contrast, learn from a massive quantity of data and take into account customer profiles, personal and past interactions, item descriptions, images, and reviews. They also use machine learning algorithms to analyze data such as sales history, market trends, stocking practices, and online and offline promotions. AI examines customer behaviors on the target items; if a customer buys an item, it is because we keep the sale records.

Predicting demand in real time is increasingly necessary for businesses to understand what they will need in the near future, both in terms of supplies and warehouse capacity. For example, when demand prediction software is used, businesses with perishable goods or zero-finish warehouses can expect the quantity and type of items that clients will want within a period of time. AI makes inventories work by providing products to end users while minimizing the amount of capital tied up in stock. Research shows the benefit of enhancing prediction accuracy to 50 percent for major retailers. According to the research, advanced retailers have already seen significant benefits in terms of stock levels through reduced stockouts and waste. By improving prediction accuracy, these major retailers could reduce overstock by 35% and stockouts by 34%. At present, the best practice for predictive analysis in a business service environment is around 75 to 95%. Demand prediction is the most important application that drives profitability for these companies. Predicting what customers will want in the near future and positioning the stock ahead of verifiable demand will increase sales and customer satisfaction.

3.2. Inventory Management

Inventory management plays a crucial part in any supply chain system, particularly in the retailing domain, where customers purchase products rather than the services or commodities consumed to make them. Maintaining inventory levels that match customer demand can be a very difficult task, yet retailers who stock too much or too little face steep costs. A longer duration of overstocking results in banking charges, the danger of goods damaged in storage, and a slow turnaround. In the retail sector, a

lengthy stockout is potentially catastrophic because it means turning customers away. Furthermore, a long restocking period gives customers the opportunity to try out competitors. As a result, there is currently a huge concentration on data-driven estimating models that can help minimize costs and avoid forgone income. These can be a single product or category of products, which are particular to the firm's designs. Forecasting purchase orders or sales in addition to estimated market demand can also assist in minimizing holding and stockout costs. Despite the fact that inventory management systems have improved, the algorithms used to predict inventory turnover rates have essentially remained the same.

AI is routinely used in supply chain systems to help figure out the order size. The figure and some machine learning systems help in inventory replenishment that makes decisions close to real-time and supports proactive decision generation based on perceptual data. Removing personnel from many automatic reordering techniques can also help to minimize errors. There may be flaws in manually updating the location of inventory materials in a business trade line. A clothing retailer has deployed a large organization to effectively monitor its stock and to accept stock delivery for certain products that were depleted. Retail inventory efficiency, which measures the ratio of stock delivered during restocking to stock sold against the proportion that should have been delivered, is attributed to solutions that are based on AI. An example of a positive AI-driven inventory system is a company that has been predicted to reduce its inventory by more than 10% as a result of using artificial neural intelligence. The system identifies demand trends and can reduce stock as a result of the increase. Similarly, a company embraced demand-forecasting techniques from machine learning in 2020 to maximize turnover rates at its parts distribution center. The project team now creates a list of the highest-urgent supplies each day, thanks to the team's use of machine-learning algorithms. Subsequently, a series of automatic solicitations is created based on user outlines. Agency inventory is now achieving favorable results. Similarly, look forward to savings while enhancing competitiveness and growth in the retail inventory industry. In today's highly competitive business world, inventory management systems built on AI provide prospective firms with genuine value. In addition to holding costs being decreased, retailers can offer high-profit products at the right time to save money.

4. Benefits and Challenges of Implementing AI in Retail Supply Chain Forecasting

Leveraging AI in retail supply chain forecasting allows for the accurate prediction of which products consumers want and when they want them. This improved visibility enhances the forecasting process, allowing for more informed decisions regarding purchasing, production, and inventory, which can lead to cost-saving efficiencies. Moreover, by improving forecasting accuracy, retailers can adapt quickly to the changing dynamics of their environment, giving them a competitive edge. The ideal way to forecast any particular product within a retail context will be driven by the specific commercial context and the nature of customer interactions, among other variables. The capacity to predict customer interaction with a product and its impact provides evidence-based support to merchandisers partnering with demand planners in providing a more compelling offer. AI can also provide sector-specific consumer behavior analysis, an accurate analysis of advertisement penetration, and can predict how this will be altered if changes are implemented.

There are a number of challenges that arise in incorporating AI into retail, notably due to the nature of AI and the need for accuracy. When leveraging AI for retail supply chain forecasting, the most noticeable and potentially challenging aspect comes from using personal data. The significant corresponding aspects are data as currency, high-value data sets, customers being anonymous, and having no explicit governing of behavior and ultimate individual behavior intention. Behaviors in retail are highly relevant, and finally, retail sectors are commercially motivated. Technical and service leadership in AI needs to be founded on cutting-edge technology while ensuring data privacy and individual behavior rights in line with existing and statutory requirements. In light of this, the allocation of the appropriate futurist lens offered through AI means of interpreting personal data in an ethical and regulatory compliance framework is essential. The key output is based on a sale price and to whom it is directed. Data protection and privacy are significant issues in forecasting customer behavior and leveraging ethical AI capabilities. The advent of the General Data Protection Regulation and the "Privacy by Design" principle underscores this. Retailers that plan to utilize the full potential of AI require robust data infrastructures and the public's trust, while transparently stating how they are using personal data and recognizing the competitive advantage of preserving personal data anonymization. Retention has to become an ethical judgment, a question of constitutional rights, and a demonstration of operational

integrity. It has to abandon its historical association with financial value, particularly in retail where personal data is and should be considered a cost of service. It also changes the ethical framework within which technology can be leveraged going forward.

4.1. Improved Accuracy and Efficiency

This paramount increase in demand forecasting prediction accuracy comes from AI's enhanced analytical capabilities. With such finely tuned algorithms, retailers can examine vast datasets to capture more granular patterns in customer demand. Once this is achieved, retailers can then combine these granular forecasts to generate a more accurate prediction for product demand. These forecasts can also be updated faster, with data being instantly processed to inform decisions in real time. Through employing AI and machine learning, the home goods e-commerce company was able to reduce its forecasting error by 30 percent. Additionally, the retail sports brand was able to increase its service levels by 4 percent. Besides quickly responding to changes in consumer demand, the increase in forecast accuracy will also enhance inventory management. This ability to better align supply chain management with consumer behavior also has benefits for reputation management. Predictive analytics from AI can lead to an improved customer experience; a reported 74 percent of retail CFOs also believe. Inventory management improvements and an enhanced customer experience ultimately translate to increased profitability. Unused stock, excess product, is often sold to liquidators at a cheaper price. Conversely, understock means retailers are unable to fulfill customer demand and may then push for a separate order of the product from the manufacturer. This fragmentation in orders adds extra costs to a company's purchasing budget. In this way, better planning helps prevent these types of fragmented purchasing spikes. By offering strategic insights, AI empowers retailers to make better overall decisions and aim for bigger profits.

4.2. Data Privacy and Security Concerns

Privacy Leakage and Security Risks: A significant consideration when AI is used to forecast demand is the potential reduction in privacy due to the data collection and analysis involved. The success of AI models relies on vast amounts of data, including specific consumer information collected from both internal and external sources. This raises several ethical and regulatory considerations, including the analyses performed and conclusions drawn by the models and the manner in which the data was collected.

Beyond the ethical aspects, an organization that handles a large amount of sensitive data is increasingly attractive to attackers. There are countless examples of customer data being stolen from companies, and if sensitive information is to be used to create AI models, this poses a significant data breach risk.

Mitigation: One possible measure to reduce privacy risk is to anonymize the data used to train the AI models. Rather than using actual identities, an organization can use unique identifiers with time limitations to perform the analysis. Additionally, data can be encrypted to ensure that it remains confidential during the analysis process. Complying with privacy measures is likely to be seen as good corporate responsibility. The violation of privacy in AI usage is especially important if a company has detailed customer profiles and significant amounts of non-anonymized data. Trust: Compliance alone, however, is not sufficient to win over the public: a study reports that a significant percentage of people would take their business elsewhere if they found a company was handling their data inappropriately, and that industry compliance has little effect on consumers' purchasing decisions. Descriptions of how trust is essential in developing the confidence and goodwill to support the adoption of online services highlight the importance of this issue. This is even more important in an industry using AI, as the general public's awareness of what machine learning could predict may be grossly overestimated, a fact which may lead to increased scrutiny and backlash.

5. Case Studies and Success Stories

1. Demand Forecasting: 7-Eleven 7-Eleven is a large chain of convenience stores with 10,500 locations across North America. Inventory management, particularly forecasting demand for highly perishable items, presents challenges that can result in spoilage, low service levels, customer dissatisfaction, and reduced profits. Artificial Intelligence Solution: 7-Eleven worked with technology partners and their team of data scientists to identify the most effective way to implement the tools. They used artificial intelligence to forecast demand, develop a normalization process that minimized noise, and successfully integrated disparate data sources. Supply chain managers were involved from the start to ensure the data used in the forecasting was practical and shared by internal partners. Outcomes: The use of AI methods enhanced their DC demand forecasting. Implementing AI introduced a system of daily management reports, which 7-Eleven uses to identify and track underperforming stores. For DC demand forecasting,

they achieved an 11% reduction of the bias and increased forecast accuracy to 82%, compared to 74% according to their baseline forecast.

2. Customer Demand Forecasting: Ross Stores Ross Stores operates over 1,313 discount clothing and homeware stores in the U.S. and employs approximately 88,334 full-time employees. Their core culture revolves around maintaining a deep commitment to customer service and supporting the communities in which they do business. Challenges: Disaster recovery and the lack of security with the legacy system. Artificial Intelligence Solution: Ross Stores turned to a technology partner and their team of data and retail scientists to implement an advanced customer demand forecasting system. Outcomes: Ross Stores was able to modernize their systems by reducing the cycle time from many hours to a refresh that is well under two hours end to end. They were able to implement sophisticated purchase order and allocation algorithms in the AI-based system.

3. Inventory Optimization: Superdry Superdry is an international clothing brand with a significant number of franchise outlets. In 2012, they employed approximately 3,375 staff with a retail, trade, franchise, and re-engineering revenue of £198,179K. Challenges: The recession hit the UK high street hard, and Superdry was unsure about the future. They had a requirement for stock but were constrained in their ability to hold. They were experiencing challenges with continued, rapid growth and increasingly complex range expansion. Artificial Intelligence Solution: Superdry worked with technology partners and their team of data and supply chain experts to develop new inventory optimization models. They implemented demand-transference modeling for visibility and analysis of the impact on late orders. Canadian divesting saw sales uplift of at least 55% in lines identified by the optimized allocation. In some instances, the top 200 selling SKUs were selling 200% more by unlocking stock from shops. Outcomes: They cut existing inventory holdings of one 3PL provider by 34% and reduced spend with another by 37%, improved customer service by reducing product outs between 10% and 20%, with an average customer service increase of 14%. ROI 619%.

5.1. Real-world Examples of AI Implementation in Retail Supply Chains

Amazon's robotics ensure lower operating expenses. Locus Robotics increases labor walk time. Online retailers can more accurately predict the demand for seasonal goods through the analysis of information received from social networks. A network of mass-

market stores excelled in supply chain operations: in its inventory, there are hours of goods transfer, and the whole process is controlled by AI. A supermarket chain introduced an AI system that blocks sales of a popular product as soon as it becomes unavailable in the supplier inventory. Due to soft switching and minimizing risk, the chain managed to reduce delivery delays. At the same time, the AI system also analyzes relevant sales statistics and proposes an increase in supplies if necessary. A distribution center supplies goods as quickly as possible to network stores, but delays still happen. After the implementation of AI, it was possible to reduce delays at the warehouses.

One of the most clear real-world examples of achievement is a grocery store chain. After implementing a forecasting tool based on AI, the chain was able to better predict the demand for goods, and after successful piloting, began to strengthen the tool's capabilities and apply it throughout the chain. The impact was immediate: it significantly improved sales and service capabilities, providing more effective stock replenishment management. At the same time, forecasting is done for the most demanded goods. The partnership used commodity insights to analyze customer behavior and demand trends in different periods before eventually deciding to sell lamb at Easter. This decision was correct, as an increase in lamb-related sales was noted in the run-up to the Easter holiday, illustrating increased customer demand. Retailers understand the possibilities of Big Data and AI to analyze human behavior, combining factors such as political and economic instability, and automatically update price and margin policies to reflect new product trends.

6. Future Direction

Given the increasing volume and complexity of data that will become available in digital retail environments, it is envisaged that the tools and techniques can be augmented in three major areas in the near future. Firstly, it is envisaged that the predictive accuracy of AI applications will be improved. Furthermore, high predictive accuracy will provide significant improvements in identifying sales events, including product launches and promotions, and hence will support the workflow of retail professionals in the industry. As AI learns from new data for predicting, for example, daily arrivals at parking locations, the volume and value of the data will increase significantly, supported by the affordable cost of data. Immediate implications of this will be the capacity to move from predictive analysis to prescriptive analysis that supports retail professionals in the

decision-making process. Secondly, future AI will be fine-tuned for retail applications and, in particular, will bring consumer behavior into the link between demand and sales. More recently, macro shopping and transaction data are becoming available at different scales, from high street to online; these could be integrated with micro shopping data. It is envisaged that this will also encompass cognitive and emotional data from diverse sources, such as physiological measures, for enhanced accuracy and insight. Finally, combining AI with other digital technologies related to retail, particularly the Internet of Things and blockchain, will provide far greater insights into customer decision-making and also streamline stock management. Generally, the use of AI and related technologies is likely to revolutionize the retail workforce and place greater emphasis on highly trained individuals and professionals. These individuals will need to have a wider range of skills and competencies. Furthermore, as many applications will need to use consumer shopping behavior and assess the impact for context-dependent products, privacy and other ethical issues will rise. In conclusion, the AI retail supply chain is one that faces rapid technological change to which it must adapt or be left behind. Overall, augmenting traditional and established time series methods with an AI algorithm provides much more accurate forecasts. Techniques for introducing very large and heterogeneous data into the supply chain forecasting workflow are lacking. The traditional focus of retail chains on price and convenience is quickly becoming outdated. Today's shoppers expect an always-on shopping experience that feels like it is tailor-made for them. It is the retailer that has been able to achieve this level of customer centricity, as seen by the ability to respond to and surpass customer expectations in real-time, that is winning in the retail market. In particular, being able to predict sales and customers' daily arrivals at different geographic scales to make retail inventory and workforce planning decisions will become important. The days when stock was managed in retail by matching demand to supply with booms and busts in stock are over. Retailers all over the world are exploring ways in which AI can enhance every part of their businesses – most importantly, the supply chain. With the way retail is currently evolving, the question is not if AI may be deployed, but how quickly and effectively retail chains will be able to adapt to this new AI era.

7. Conclusion

AI stands in the center of digitization to provide enhanced accuracy, scalability, and speed compared to single intelligent systems. From the discussions, it can be

synthesized that a number of providers, consultants, researchers, and practitioners are experimenting with or proposing artificial intelligence algorithms in the field of retail supply chain forecasting. These AI algorithms, compared to the traditional ones, can address issues such as high demand seasonality, intermittent as well as locally dependent sales, demand data with observable insensitivity to retail prices, and also are able to identify periods of cross-forecasting improvement over conventional neural networks. However, in order to benefit from AI approaches, retailers have to upload their forecasts into the system and use these enhanced forecasts in the face of any other managerial complexities including data privacy and security concerns which are more cumbersome than in traditional forecasting systems. In general, it can be concluded that despite hopes of being dominated by artificial intelligence, retail supply chain forecasting is still a young work in progress of case study examples. Artificial intelligence and data analytics are creating a powerful shift in how retailers are able to forecast supply chain stock demands. This is of particular importance as both market demands and the available technologies behind these demands continue to shift. These shifts have forced organizations to radically rethink how they operationalize their value chains. As such, in order to maintain sustained competitive advantage, supply chains need to continue to evolve beyond using traditional statistics-driven supply chain processes toward those that use AI algorithms to provide a new level of forecasting accuracy and operational efficiency.