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Artificial Intelligence Methods for Demand Forecasting

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Abstract: ***The proper selection of a demand forecasting method is directly linked to the success of supply chain management (SCM). However, today's manufacturing companies are confronted with uncertain and dynamic markets. Consequently, classical statistical methods are not always appropriate for accurate and reliable forecasting. Algorithms of Artificial intelligence (AI) are currently used to improve statistical methods. Existing literature only gives a very general overview of the AI methods used in combination with demand forecasting. This paper provides an analysis of the AI methods published in the last five years (2017 - 2021). Furthermore, a classification is presented by clustering the AI methods in order to define the trend of the methods applied. Finally, a classification of the different AI methods according to the dimensionality of data, volume of data, and time horizon of the forecast is presented. The goal is to support the selection of the appropriate AI method to optimize demand forecasting.***

Keywords: Demand Forecasting; Supply Chain Management; Artificial Intelligence; Machine Learning; Deep Learning; Review; Analysis

1. Introduction

The era of stable markets is history. Nowadays companies confronted with highly complex scenarios characterized by unpredictable situations such as monetary crisis, pandemics, climate change, and supply constraints. Additionally, growing demand for fully customized products in the shortest possible time has aggravated this situation [1].

This increasing complexity hinders the desired transparency of material and information flow between supply chain members, which is essential to ensure the success of supply chain planning (SCP) and to improve the overall value chain resilience [2].

Demand forecasting represents a solid basis for planning and procurement processes that make the supply chain more responsive and efficient [3, 4]. Therefore, the improvement of demand forecasting methods has become more and more important for manufacturers, distributors and retailers [5–7].

Different methods are adapted to forecast demand. These can be statistical, AI - based, or hybrid methods, which combine the characteristics of a statistical model with a model from the AI domain [8]. Statistical methods provide accurate forecasting results and are very useful. Currently, due to increasing data dimensions and data volume, these classical methods face challenges and do not always meet the requirements of manufacturing companies [6, 9, 10]. With the use of AI in SCM new methods have been proposed. Which combine traditional time series forecasting with machine learning methods or use artificial neural networks to refine and improve the demand forecasting process [11].

Machine learning (ML) is a subarea of AI, which works with self - learning algorithms. ML methods aim to improve their results based on experience gained from available historical data [12]. Furthermore, ML methods shown to perform well with large amounts of noisy data, such as those typically found in historical demand data. Due to the large number of existing AI methods and the lack of transparency in their classification, Liu et al.

Propose a taxonomy to classify them into traditional ML methods and deep learning methods. Subsequently, each category can be divided into supervised and unsupervised learning [13]. Demand forecasting represents a research field in continuous development [14], which increases the complexity of identifying a suitable method for each scenario. In addition, the current literature provides a limited overview

of demand forecasting methods, especially in relation to manufacturing companies.

Therefore, the aim of this paper is the review and analyse currently used AI methods, focusing on demand forecasting in SCM of manufacturing networks. Furthermore, a classification is presented by clustering the AI methods in order to define the trend of the methods used. Finally, this publication presents a classification of different methods based on data characteristics, which supports the AI method selection for demand forecasting based on user requirements.

2. Methodology

This paper uses a structured literature review to identify existing methods for demand forecasting.

Demand forecasting:
Demand forecasting is the process of estimating future demand by analysing data. In very simple terms, it means, "**Predict how interested consumers are in buying a product"**. These forecasts are based on historical sales data, current market trends, and other external factors.

Demand Planning:
Demand planning or demand planning is a higher - level process that not only uses demand - forecasting forecasts, but also includes planning and managing inventory quantities, production, and procurement strategies. It is about making sure that "**The right product is available in the right place at the right time"** to meet predicted demand. In a separate article, we will go into more detail about the different requirements for the two concepts mentioned.

This article addresses the question of the impact of the application of artificial intelligence in demand forecasting. Also known as "Predictive Analytics for Demand Forecasting".

You could believe that supply chains have been professionalized from start to finish for some time as prime examples of demand forecasting and general demand planning. Not at all.

Status Quo Supply Chain Management:

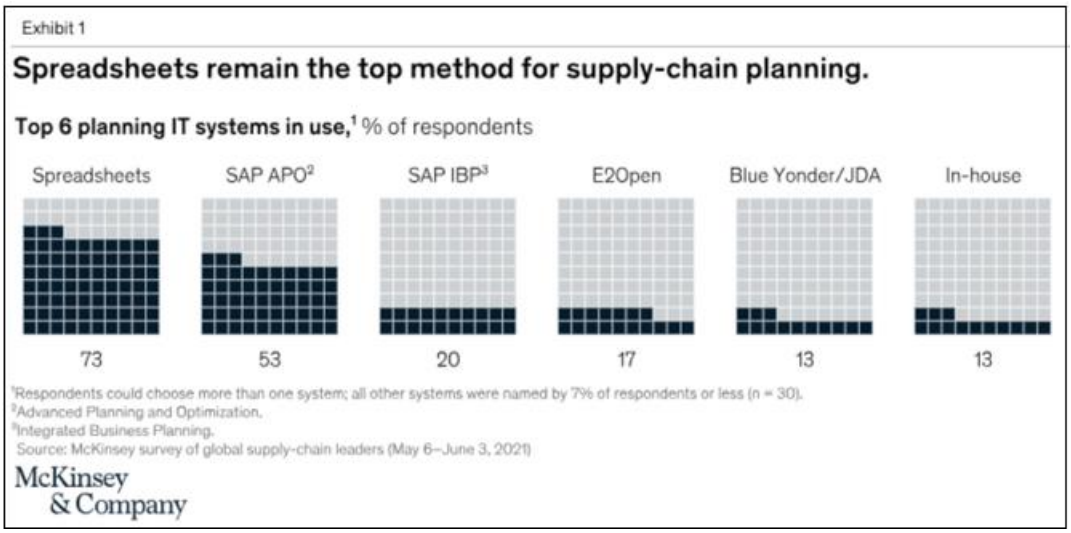


Figure 1: Tables remain the most used method for supply chain planning).

A McKinsey report from 2021 revealed that almost 75% of supply chain executives use manual methods for supply chain planning, primarily spreadsheets. In other words, Excel. It is hard to believe. This dependency naturally increases the risk of human error and results in time - consuming data collection and processing, which often results in outdated information.
In addition, companies usually work in isolated environments, which complicates the process, as technical systems such as artificial intelligence must collect data from various independent sources.

Simply - networking data by breaking down data silos provides an enormous performance boost. In combination with artificial intelligence, the industry is proverbially reaching the next level here, which, according to the report, "Global "from Research and Markets looks as follows:

Artificial intelligence (AI) is used in the area of SCM **17.5 billion US dollars worldwide by 2028** will achieve, with AI - powered supply chains **thanks to lower risks and lower overall costs** To over **67% more effective** are.

That is good news. So let's look at how artificial intelligence reduces both risks and costs to make supply chain management more effective.

The key benefits of AI for demand forecasting:

The integration of artificial intelligence in demand forecasting is, unsurprisingly, a major step forward in supply chain management. This is because AI enables highly accurate forecasting of future demand and thus overcomes the limits of conventional forecasting methods, which often rely heavily on past patterns and simplified assumptions.

By using machine learning, AI algorithms are able to **huge amounts of data** both in the **past** as well as in **real time** toward **analyse**; in order, **complex patterns and trends** toward **recognize** that could easily miss human analytics. This results in more accurate and detailed forecasts, which are crucial for various industries such as retail, life sciences (life sciences), the semiconductor industry or fintech (financial technology).
Let us look at it in detail:

Efficiency in data processing:
AI is ideal for structuring and analysing extensive data sets quickly and accurately. In contrast to traditional methods that require extensive manual input (such as using spreadsheets), AI streamlines the process of data processing. The result is a more efficient demand planning process that frees up time for strategic decisions and reduces the risk of human error.

Due to the variety of data, shipping, for example, according to Lloyd's Register (Maritime Performance Services) Only 10% of ship data taken into account, while AI models can now view almost 100% of ship data and process it immediately.

Accurate and dynamic forecasts:
AI offers a sophisticated approach to forecasting by being able to independently select and combine suitable methods for different products and levels. This granular approach results in higher accuracy of forecasts, which is crucial for well - founded decisions in the supply chain.

Comprehensive data integration:
Particularly noteworthy is the ability of artificial intelligence to incorporate both internal and external data into forecasts. It can identify causal relationships between various factors, such as market trends and economic data, which influence demand. This level of integration provides a holistic view of the market that traditional methods may overlook.

Quick responsiveness:
Algorithms adapt quickly to market fluctuations — a key advantage in today's volatile environment. This adaptability is particularly valuable when it comes to responding to unexpected events or “black swan” events, such as the COVID - 19 pandemic, which are significantly influencing demand patterns.

Improved decision - making through clarity:
Artificial intelligence is also a big step towards clear decision - making. By accurately identifying outliers, AI not only shows potential fluctuations, but also provides a comprehensive understanding of their impact on the business. This early recognition enables timely and effective intervention and ensures that decisions are not only reactive but also strategically oriented.

Better supply chain relationships:
The so - called bullwhip effect describes the intensification of demand fluctuations along the supply chain, in which small fluctuations in demand at the end of the supply chain lead to disproportionately large fluctuations in order quantities and inventories among suppliers.

Accurately predicting AI minimizes the bullwhip effect and leads to better inventory levels. This in turn leads to more efficient planning by stakeholders in the supply chain reduces stress and improves collaboration.

Democratizing data science:
AI also enables people without extensive knowledge of data science to make complex demand forecasts. The self - learning systems create and adapt the models as needed, so team members can focus on strategic tasks while leaving the quantitative work to AI.

Improving forecasts over time:
With every iteration of data analysis, AI in demand forecasting continues to evolve and improve. Through machine learning, AI systems are able to learn from new data

and refine their predictive models over time. This continuous improvement is leading to forecasts that are ever more accurate. The more scenarios the system plays through and the more feedback it incorporates, the better it can identify subtle market trends and demand shifts.

This dynamic learning process ensures that companies are not only equipped with the currently best forecasting models, but are also able to adapt to changing market dynamics and develop further in order to maintain a competitive advantage in demand planning.

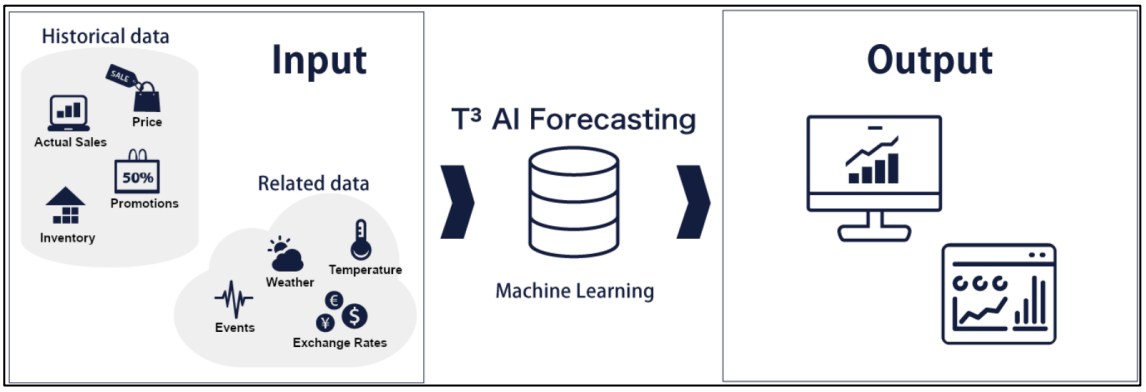
Overall, the trend is obvious — these benefits show how artificial intelligence transforms demand forecasting from a labour - intensive, error - prone process into a strategic, data - driven approach that improves efficiency, accuracy, and responsiveness in supply chain management.

Food manufacturer's demand forecast, on average, has an accuracy of 80% or higher when utilizing AI:
A food and beverage manufacturer is utilizing the power of machine learning to enhance its demand forecasting capabilities for a particular product at a convenience store. By inputting a wealth of historical performance data from the past 2 - 3 years into an advanced AI forecasting engine, the manufacturer is able to make use of complex algorithms and statistical models to predict the sales volume for the upcoming two months with a high degree of accuracy.

The machine learning algorithm used in this process is designed to continuously learn and adapt, taking into account a wide range of factors that influence demand, such as weather, economic indicators, consumer sentiment, and competitors' prices and trends.

This allows the manufacturer to not only predict the future sales volume but also identify potential risks and opportunities, giving them a competitive edge in the market.

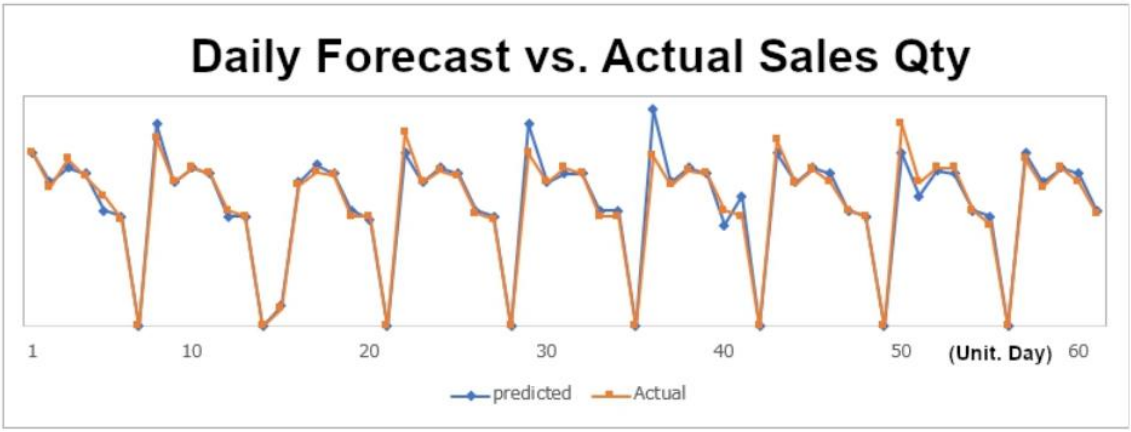
Moreover, the manufacturer also able to use the forecasted sales volume to optimize production schedules and inventory management, reducing waste and increasing efficiency. By using this advanced machine learning system, the manufacturer is able to make data - driven decisions that improve their bottom line and provide a better service to their customers.



The food and beverage manufacturer is able to gauge the effectiveness of their AI forecasting system by comparing the actual two - month performance data with the data calculated by the AI Forecasting engine. The results have been impressive, with the forecast quantity difference being around 6% on average, considered a highly acceptable margin of error. Additionally, the forecast accuracy has been consistently high, with an average of 80% or higher.

This level of accuracy is particularly important for the manufacturer, as it allows them to make more informed decisions and optimize their operations. By having a high level of confidence in their demand forecasts, the manufacturer can better plan production schedules and inventory management, which helps them to reduce waste and increase efficiency.

Furthermore, by consistently maintaining an accuracy rate of 80% or higher, the manufacturer is able to improve their forecasting capabilities over time, which will enable them to make better decisions and anticipate market trends more effectively. This ultimately leads to increased profitability and a better service to their customers.



3. Conclusion

In summary, artificial intelligence has many benefits for forecasting demand. However, their successful implementation requires overcoming challenges in data quality, system integration, and ongoing management. Companies can use the power of artificial intelligence to improve their supply chain management in the areas of costs, risk, and efficiency.

Accurate demand forecasting enables manufacturing companies to increase overall supply chain resilience. AI methods alone or in combination with statistical methods significantly improve the accuracy of demand forecasting methods. Additionally, in order to avoid demand distortion - bullwhip effect - and thus ensure the success of the supply chain, transparent communication between the members involved in the demand forecasting process is essential. However, this publication shows that most of the literature reviewed concentrates only on demand forecasting from the retailer's perspective. This shows the absence of "collaborative forecasting" which is indispensable for upstream members of the supply chain.

References

[1] Bauernhansl T (ed.). Management in der Produktion. Berlin, Heidelberg: Springer Vieweg; 2020. Reference
[2] Kummer S. Grundzüge der Beschaffung, Produktion und Logistik.4th ed. München: Pearson Studium; 2018.
[3] Chopra S, Meindl P. Supply Chain Management: Strategy, Planning, and Operation; 2016. [4] Alsanad A. Hoeffding Tree Method with Feature Selection for Forecasting Daily Demand Orders. IEEE; 2020, p.223–227.
[4] Demand forecasting meets artificial intelligence – Blog (Pacemaker. ai)
[5] AI Demand Forecasting – Blog (zionex. com/ai - demand - forecasting/)