Impact of Deep Tech on Supply Chain Management

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Abstract

The integration of deep technology tools like Artificial Intelligence (AI), the Internet of Things (IoT), and predictive analytics is transforming how businesses approach supply chain management. Traditional methods are increasingly being replaced by AI-driven models that can process large volumes of real-time data, allowing companies to better predict market changes, streamline inventory, and enhance operational efficiency. This study examines the effects of these technologies across different industries, emphasizing their ability to minimize waste, improve supply chain responsiveness, and generate cost savings. By presenting case studies from sectors such as retail, automotive, food, and fashion, this research highlights the significant impact of deep technologies on the future of demand forecasting and supply chain management.

Keywords: Artificial Intelligence, IoT, Supply Chain Management, Predictive Analytics.

INTRODUCTION

In today's fast-changing business environment, the use of advanced technologies like Artificial Intelligence (AI), the Internet of Things (IoT), and predictive analytics has revolutionized supply chain management. Traditional forecasting methods, which are depended largely on historical sales data and manual analysis, are being substituted by AI-powered systems that can handle large volumes of real-time data. These advancements allow companies to predict market changes, optimize inventory, and improve operational efficiency.

Supply chain management is a multifaceted system that encompasses various entities, resources, activities, and technologies collaborating to produce and deliver goods or services from raw material suppliers to end consumers. This process includes several interconnected steps, such as procurement, demand forecasting, production, inventory management, logistics, and customer service. A well-functioning supply chain guarantees that products arrive at the correct location, at the appropriate time, and in the right quantities, all while keeping costs low and enhancing customer satisfaction.

This study looks into how deep technologies influence supply chain management, focusing on how companies utilize AI, IoT, and big data analytics to enhance efficiency. Through various case studies and empirical research, the paper investigates the importance of predictive models in streamlining operations, reducing waste, and boosting customer satisfaction. By showcasing industry-specific applications and success stories, this research seeks to emphasize the transformative power of deep technologies in

redefining the future of supply chain management.

Literature Review

Application of AI in the Retail Sector

Walmart has effectively used machine learning algorithms to forecast demand at a detailed store level by combining data from sales records, weather predictions, and local events. This strategy has led to a 30% decrease in stockouts and a 25% increase in inventory turnover rates, resulting in annual savings of around $1.5 billion in logistics expenses (Narne, Harish., 2021). Furthermore, AI-driven checkout systems have reduced wait times by 40%, enhancing customer satisfaction (McKinsey & Company, 2022).

Application of AI powered supply chain planning systems in Automobile sector

Toyota employs AI-driven supply planning systems to align production schedules with demand forecasts. By integrating predictive analytics into their planning, Toyota has cut lead times by 20% and boosted production efficiency, resulting in annual savings of $500 million in logistics and raw material procurement (Narne, Harish., 2021; Kagermann, Wahlster, & Helbig, 2013).

Maruti Suzuki implements AI-based systems to assess vendor performance, ensuring that suppliers adhere to quality and delivery standards. This initiative has resulted in a 15% increase in on-time deliveries and a 10% decrease in defective parts (Singh, A., 2020).

Mahindra & Mahindra leverages AI-powered image recognition technology to examine vehicles prior to their departure from the assembly line, halving manual inspection time and enhancing defect detection accuracy by 30% (Choudhury & Vashisht, 2023).

Applications of AI and Big Data in Food Industry in avoiding wastage of food in food industry

Accurate demand forecasting and effective inventory management are crucial for reducing food waste that results from overproduction and spoilage. By leveraging AI and Big Data, organizations can enhance their ability to predict consumer demand through the analysis of:

- Historical Data: Trends in past sales and seasonal fluctuations.
- External Factors: Influences such as market conditions, weather changes, holidays, and promotional events.
- Consumer Behaviour: Insights into purchasing habits and preferences (Yasmin et al., 2023).

AI Tools and Techniques:

Machine Learning Models include linear regression, decision trees, and neural networks, which are used to predict demand.

Big Data Platforms consist of Apache Hadoop, Spark, and Tableau, which facilitate data analysis and visualization (Chen, Chiang, & Storey, 2012).

Impact on Food Waste:

Minimized Overstocking: AI assists retailers in keeping inventory at ideal levels, which lowers the chances of excess products going to waste. This has led to a 20% decrease in food waste for large supermarket chains, resulting in savings of over $300 million each year in lost inventory (ReFED, 2023).

Enhanced Resource Management: It helps avoid underproduction that could cause supply shortages, allowing businesses to optimize their stock levels (Fernández-Vázquez et al., 2023).

Nestlé India uses AI technology to enhance food safety and maintain product quality, leading to a 35% decrease in food contamination incidents and a 15% reduction in waste at processing plants, resulting in annual savings of ₹100 crore.

Use of AI in Amazon Warehouse

In its early days, Amazon struggled with inventory management in its warehouses, which often resulted in human errors when trying to find the correct materials. To tackle this issue, the company implemented warehouse configuration systems that enable quick sorting of products and effectively utilize FIFO (First In, First Out) techniques. (Li, Z,.2024)

The implementation of AI technology has led to significant improvements in various operational metrics:

- A 30% reduction in out-of-stock rates.
- A 40% boost in warehouse processing efficiency.
- An annual savings of $500 million in logistics and operational expenses.

Additionally, AI-powered Kiva robots have enhanced fulfilment speed by 50%, cutting delivery times from 60 hours down to just 24 hours (Kaplan & Haenlein, 2023).

Application of Predictive Analytics in Fashion Sector of Shanta Denims Ltd., Bangladesh.

AI technologies have significantly improved production processes by automating tasks that were once labour-intensive.

With the introduction of robotic sewing machines and automated fabric-cutting systems, production speed has increased by 35%, errors have been reduced by 20%, and annual production costs have been lowered by $10 million (Shamim, 2022; Choudhury & Vashisht, 2023).

In terms of demand forecasting, AI-powered tools have enhanced prediction accuracy by 30%, allowing brands to cut down on unsold inventory by 25% (Bhattacharya, 2022).

Additionally, AI technologies facilitate real-time inventory management, boosting stock efficiency by 20% and decreasing markdown losses by 15% (Hur, E., & Beverley, K., 2023)

Philips: Using IoT and A.I taxation for circularity in electric devices

Philips showcases effective strategies for leveraging digital technologies within a circular economy framework in the electronics sector. The company employs AI and IoT sensors to enhance the reuse, recycling, and repurposing of electronic products, including household appliances and medical devices. (Bressanelli et al., 2018) (Farazi et al., 2024).

Impact of AI-Powered Circular Economy Initiatives:

Predictive AI-driven reverse logistics has enhanced product lifespan by 30%, significantly cutting down on waste (Kumar et al., 2021).

AI algorithms optimize collection schedules for used products, boosting the recycling rate by 40% (Farazi et al., 2024). IoT sensors track product usage and maintenance, resulting in a 20% decrease in premature disposal (Bressanelli et al., 2018).

Annual savings of €200 million have been achieved through improved refurbishment and recycling strategies (Bressanelli et al., 2018; Farazi et al., 2024).

Research Methodologies

In this research, we are using qualitative approach where we analyse around 15 other researches which were conducted in applying deep tech tools in demand forecasting at various sectors of industries around the world. We are analysing secondary data by reviewing the research papers and understanding its given case studies.

Analysis of AI Applications Across Industries

The use of Artificial Intelligence (AI) in various sectors like retail, automotive, food, fashion, and electronics has led to notable improvements in efficiency, cost savings, and better decision-making. A major insight from the examples presented is that AI streamlines operational processes, boosts predictive accuracy, and supports sustainability initiatives.

1. AI in Retail: Efficiency Gains and Customer Experience

Key Insights:

Walmart's use of AI-driven demand forecasting has led to a 25% improvement in inventory turnover and a 30% reduction in stockouts, translating to annual savings of $1.5 billion. The implementation of automated checkout systems has decreased customer wait times by 40%, which has significantly boosted customer satisfaction.

Analysis:

Retailers that implement AI-based analytics for inventory management can gain a competitive edge by avoiding stock shortages and minimizing overstock. Walmart's achievements demonstrate how AI can effectively match supply with changing demand, helping to avert losses from unsold items or missed sales. The influence of AI in this area is twofold: it enhances operational efficiency through cost savings and improves the customer experience by reducing wait times.

2. AI in Automobile Supply Chains: A Data-Driven Approach

Key Insights:

Toyota's use of AI in planning has cut lead times by 20%, resulting in annual savings of $500 million in logistics expenses.

Maruti Suzuki's vendor monitoring system has achieved a 15% increase in on-time deliveries and a 10% decrease in defective parts.

Mahindra & Mahindra's AI-driven quality inspection has halved the time needed for manual inspections and enhanced defect detection by 30%.

Analysis:

AI has transformed the automobile industry by improving supply chain visibility and coordination with vendors. Predictive analytics helps in procuring materials efficiently, minimizing excess inventory and waste. The use of image recognition technology to automate quality control showcases AI's ability to standardize production outputs, resulting in consistent quality and fewer defects.

Businesses that do not adopt AI in their supply chain planning may face inefficiencies like delayed deliveries, poor vendor compliance, and increased defect rates, which can negatively affect their brand reputation and customer satisfaction.

3. AI in Food Industry: Waste Reduction and Sustainability

Key Insights:

AI-powered demand forecasting has cut overstocking by 20%, leading to annual savings of $300 million for large supermarket chains.

Nestlé India's use of AI for quality control has achieved a 35% decrease in food contamination and a 15% reduction in waste, resulting in annual savings of ₹100 crore.

Analysis:

The food industry greatly benefits from real-time AI analytics that help predict demand, which in turn minimizes waste. By incorporating machine learning models into their supply and demand forecasting, businesses can fine-tune their inventory levels, leading to less perishable waste and increased profitability.

Moreover, AI-driven quality control systems improve adherence to food safety regulations, lowering legal risks and boosting consumer confidence. As regulatory bodies enforce stricter rules regarding food waste and environmental impact, the move towards AI-powered sustainability initiatives will be essential.

4. AI in Warehouse Management: Amazon's Logistics Edge

Key Insights:

Kiva robots powered by AI boosted fulfilment speed by 50%, cutting delivery times from 60 hours down to just 24 hours.

The use of AI in warehouse configuration led to a 30% reduction in stockout rates and a 40% increase in processing efficiency, resulting in annual savings of $500 million.

Analysis:

Amazon's success with AI showcases the significant impact of automation and robotics on warehouse operations. By implementing AI-driven logistics management, they have not only made order fulfilment more efficient but also increased the scalability of e-commerce businesses.

Companies that embrace similar AI-powered warehouse solutions can expect quicker order processing, lower operational costs, and better inventory accuracy. Conversely, businesses that fall behind in adopting AI may encounter inefficiencies, higher overhead costs, and slower order fulfilment, which could negatively affect customer retention.

5. AI in Fashion Industry: Demand Forecasting and Process Optimization

Key Insights:

Shanta Denims Ltd. has enhanced its production capabilities with AI-powered sewing machines, boosting speed by 35% and cutting errors by 20%.

Additionally, predictive analytics have helped reduce unsold inventory by 25%, and real-time inventory tracking has led to a 20% improvement in stock efficiency.

Analysis:

AI has transformed the fashion industry by streamlining production processes and minimizing overproduction. With real-time demand forecasting powered by AI, brands can steer clear of excess inventory and markdown losses, which ultimately boosts profit margins.

The automation of labour-intensive tasks like sewing and fabric cutting greatly enhances manufacturing accuracy and productivity, lessening the reliance on manual labour. However, the rise of AI-driven automation brings up concerns about job displacement, highlighting the need for upskilling programs to equip employees for roles in a technology-focused environment.

6. AI in Circular Economy: Phillip's Sustainability Model

Key Insights:

Using predictive AI for reverse logistics has extended product lifespans by 30% and boosted recycling rates by 40%.

Additionally, AI-enhanced collection scheduling has led to annual savings of €200 million by streamlining refurbishing processes.

Analysis:

Philips' use of AI in sustainability efforts highlights the technology's importance in promoting circular economy models. By utilizing AI-enabled IoT sensors, businesses can monitor product lifecycles, facilitating effective reuse and recycling.

With sustainability regulations becoming more stringent, AI-driven circularity models are set to become standard practice in the industry, rather than just a way to stand out from competitors. Companies that do

not adopt AI-powered circular strategies may face regulatory penalties, harm to their reputation, and inefficiencies in managing waste.

Overall Conclusions and Future Outlook

1. Embracing AI is essential for businesses today – those that do not incorporate AI into their supply chain planning, demand forecasting, and production processes may face increased operational costs and inefficiencies.

2. AI is transforming industries in specific ways – whether it's real-time inventory management in retail or predictive quality control in manufacturing, AI applications differ but consistently enhance efficiency and reduce costs.

3. Focusing on sustainability and waste reduction through AI will set businesses apart – companies that adopt AI-driven circular economy models will find themselves ahead in regulatory compliance and cost savings.

4. The roles of the workforce will change with AI – as AI takes over repetitive tasks, businesses need to invest in upskilling their employees to prepare them for decision-making roles that involve AI assistance.

5. Successful AI integration hinges on strong data governance – organizations need to create solid AI ethics policies to ensure unbiased decision-making and protect data security in AI-driven business practices.

As AI technology advances, companies that actively incorporate AI into their operations will take the lead in their industries, while those that are reluctant may face challenges with inefficiencies and competitiveness. The future will favour businesses that utilize AI's predictive abilities to make informed decisions, enhance supply chains, and promote sustainable growth.

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