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AI-DRIVEN DIGITAL TRANSFORMATION IN SUPPLY CHAIN PLANNING

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Abstract

Artificial intelligence (AI) is becoming increasingly integrated into supply chain management, rendering a paradigm shift in how businesses are optimizing their operations. As global supply chains become increasingly complex. AI presents a viable option for addressing the growing complexities. AI assists in data-driven decision-making and streamlining the various aspects of supply chain planning. This is the reason that in 2025, as many as 38% of companies thinks that AI is critical to their businesses.

Various projections estimate usage to reach AI in the supply chain planning to reach $5.75 billion by the end of 2025. This huge number reflects the rapid adoption of AI technologies in supply chain management. The purpose of this paper is to render a comprehensive review of the impact of AI on supply chain planning. This will be of help to businesses interested in utilizing AI-driven technologies in their logistics planning. AI-driven supply chain planning solutions encompass an array of applications, including inventory optimization, demand forecasting, predictive maintenance, and supplier relations management to enhance business efficiency, reduce costs, and improve the overall performance within the supply chain (Simchi-Levi, Kaminsky, 2019). We will discuss the implications and various benefits as well as offer suggestions for the future. We hope that this paper will help businesses interested in utilizing AI-driven technologies in their logistics planning.

Keywords: Artificial Intelligence, Supply chain planning, Logistics, demand forecasting AI in business planning.

I. INTRODUCTION

In the current era, customer expectations have soared to unprecedented heights, leaving supply chain planning at a critical juncture. Precision, speed, and transparency in supply chain management have become baseline requirements rather than competitive advantages. Logistics firms are on the verge of adapting to this transformation by integrating digital tools through artificial intelligence. Integrating AI-based digital transformation has become the survival strategy for adept supply chain planning and improved responsiveness to customer demands.
According to Bartak et al. (2010), the term artificial intelligence planning and scheduling in

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supply chain management refers to the set of methods that focuses on making intelligent system decisions within the supply chain management paradigm. AI-powered solutions have the potential to revolutionize stock management owing to their capacity to handle massive volumes of data. These intelligent systems are capable of analyzing and interpreting huge data sets and thus help in delivering real-time actionable insights for demand and supply planning (Ben Daya et al., 2019)

II. IMPACT OF AI-DRIVEN DIGITAL TRANSFORMATION IN SUPPLY CHAIN PLANNING

The impact of AI on supply chain planning has been extensive. As much as 38% of the industry respondents agreed that AI is critical for supply chain planning in their industry (Figure 1). transportation and logistics industries have witnessed a boom in digital transformation over the past five years. A recent study from HERE Technologies and AWS has found that about 19% of logistics companies make use of AI for their advanced use cases, such as demand forecasting and supply chain management. Also, logistics businesses are able to rely on real-time monitoring to enhance transparency across the supply chain. By making use of IoT and data analytics in monitoring, they will be able to ensure a resilient and customer-centric supply chain.

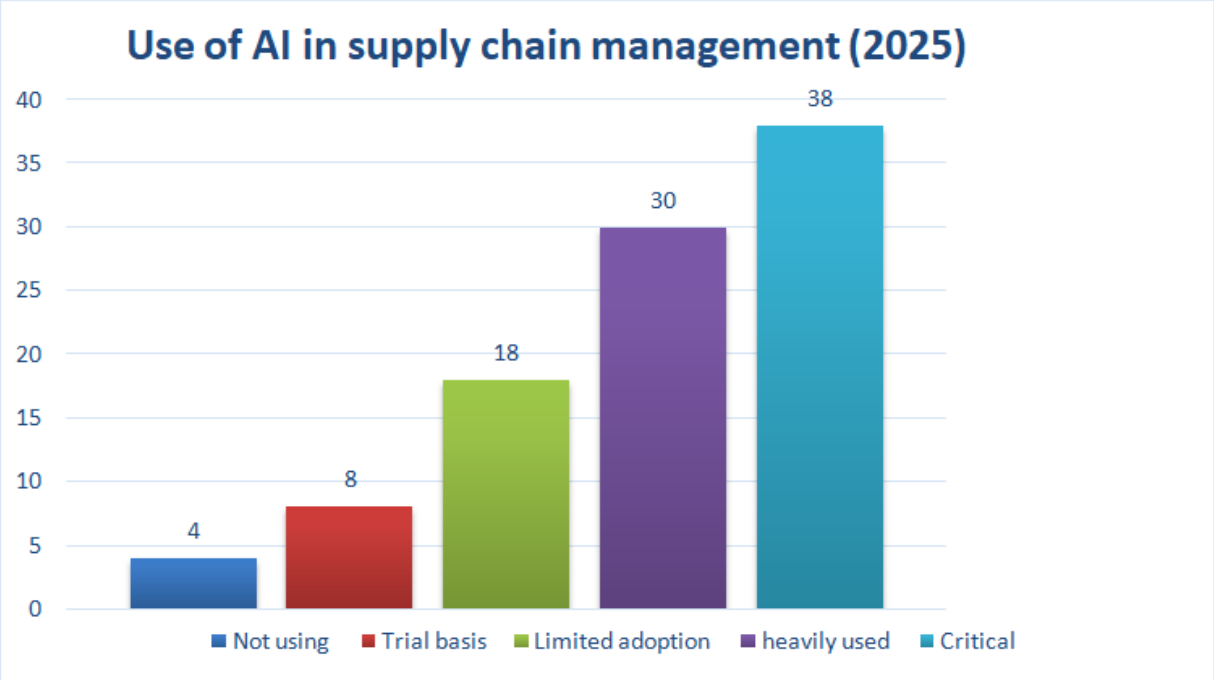

Figure 1: Graph depicting the use of AI in supply chain management

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III. BENEFITS OF AI-LED DIGITAL TRANSFORMATION IN SUPPLY CHAIN PLANNING

1. Cost reduction: AI-powered predictive analytics will help detect equipment failures in advance, mitigating repair costs and downtime. As they analyze historical data and market trends to predict demands accurately, they help reduce over-stocking and under-stocking scenarios. The companies have been able to save on various aspects such as storage, labor, and logistics costs. Some of the companies reported a 15% reduction in logistics costs alone.
2. Improved efficiency of supply chains: AI analyzes the real-time data from IoT devices, supplier networks, and ERP systems to optimize logistics and inventory. RPA helps automate repetitive tasks such as order processing, invoicing, etc.
3. Scalability: AI and cloud computing help businesses to scale their supply chain operations without costly investments in infrastructure. AI also reallocated resources dynamically on the basis of business needs and changing demands.
4. Enhanced agility: One of the significant advantages of the usage of AI is the quick adjustments that companies can make in case of increased demand.
5. Improved customer experience: The order fulfilment is far superior, and therefore, the customer experience is excellent. Supply chain planning can reduce delivery times, and customers can have a better experience overall as they are able to track their orders, raise queries, and get personalized recommendations.

Figure 2: The business advantage of having AI in supply chain
Source: Tina. (2023, February 24). Artificial intelligence (AI) in supply chains and logistics. ThroughPut Inc.

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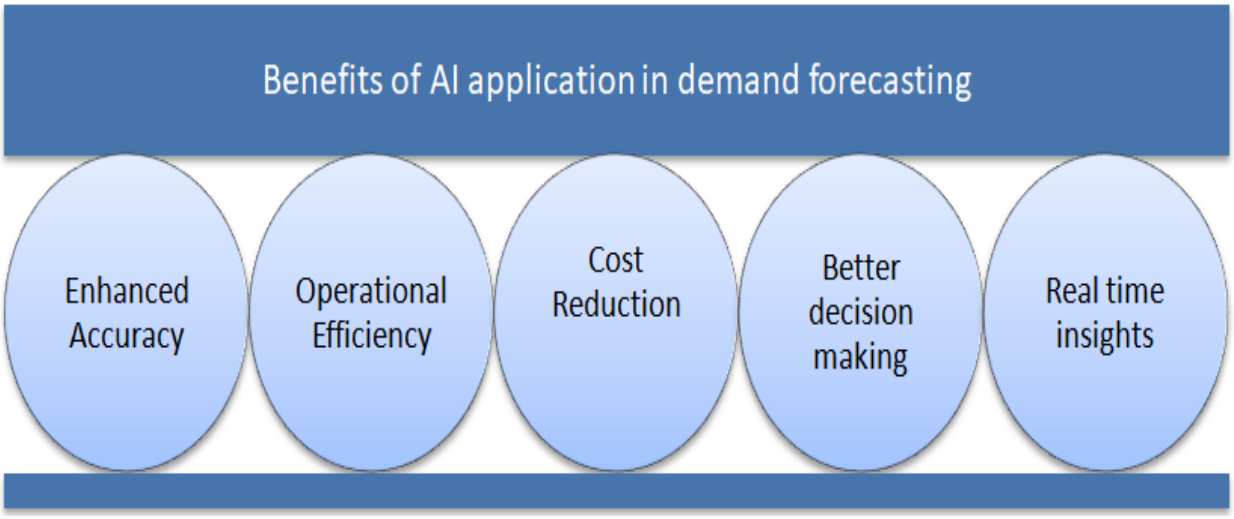

Figure 3: Applications of AI in demand forecasting and supply chain management:

AI can play a crucial role in optimizing demand forecasting, which is key to supply chain planning. AI analyzes historical data, market trends, and other factors in an attempt to predict the future demands of the business accurately. This indeed helps companies to manage their operations efficiently (Chopra and Meindl, 2019). With such predictions, businesses can plan their inventories. It also helps businesses to reduce stock-out situations and improve their operational efficiency, along with saving costs. The AI algorithms will continuously analyze the data on sales, lead times, supplier performance, and other variables to balance the stock levels and customer demands. Also, predictive maintenance by AI helps companies anticipate equipment failure and schedule maintenance proactively, reducing downtime and supply chain disruptions (Zhang, Deng, and Chen, 2019).

IV. AI IN WAREHOUSE AUTOMATION

The scope of warehouse automation includes managing inventory, picking up orders, packing orders, and shipping them to end customers. By automating warehouses in the supply chain and by implementing automation in stock storage and retrieval, businesses are able to benefit extensively. They can also make use of conveyors, automated vehicles, and robotic arms to stock and retrieve the inventory in the warehouse (Murray et al., 2017). Businesses can also make use of voice-directed picking, picks-to-light systems, and other recent order-picking technologies to improve the efficiency of their warehouse. This also helps them in mitigating errors related to stocks (Kanth et al., 2020). Automation through AI technologies extends to automated packing and shipping processes, where robotic systems are used to package the products, print the shipping labels, and load the shipments into the trucks (Ivanov &Dolgui, 2019).

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In broader terms, here are some numbers to show the benefits of AI usage in warehouse automation:

• Storage space can be optimized with up to 85% more space in the warehouse.
• Manual labor is significantly reduced (up to 2/3)
• Pick accuracy can be improved by 99%

V. TRANSPORTATION OPTIMIZATION

Businesses can streamline their transportation processes efficiently by optimizing transportation functions in their supply chain. They can also reduce costs and enhance the overall efficiency of their business through this optimization. By harnessing the power of AI, businesses can achieve route optimization. It also helps businesses analyze traffic conditions, weather forecasts, and delivery schedules to plan the best route possible for transporting their goods (Papadimitriou et al., 2020).

By harnessing the advantages of predictive analytics powered by AI, businesses will be able to achieve clarity on their stock demand patterns and optimize resource allocation efficiently by avoiding bottlenecks (Christopher, 2016). Thus, AI helps businesses anticipate demand fluctuations in advance and motivate them to adjust their transportation plans accordingly.

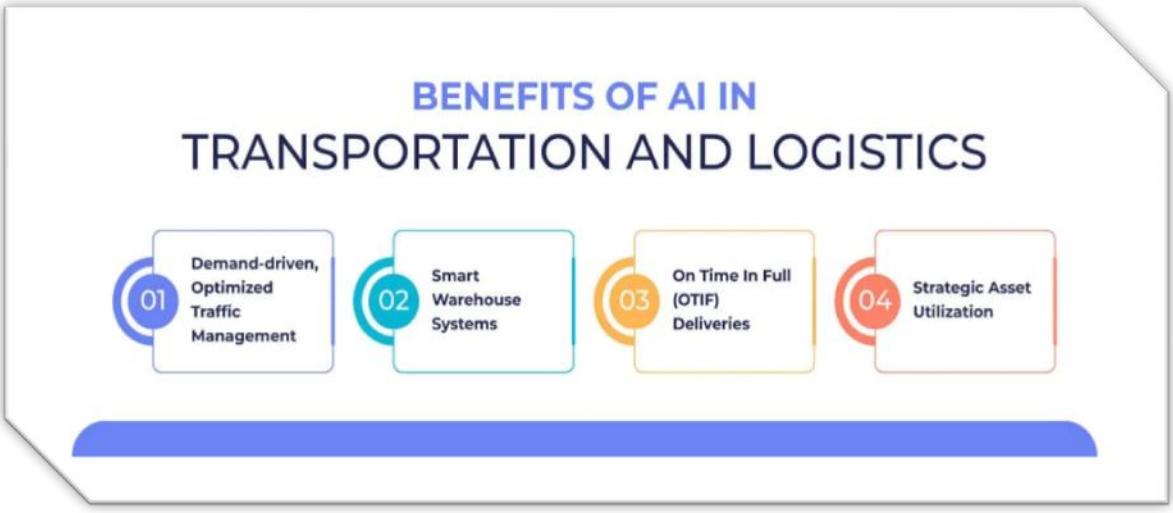

Figure 4: Benefits of AI in transportation and logistics
Source: SigmaSolve. (n.d.). How AI is shaping the future of transportation and logistics. Sigma Solve.

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VI. ROLE OF AI IN SUPPLIER RELATIONSHIP MANAGEMENT:

Supplier relationship management is a crucial aspect of supply chain management. It indeed facilitates a mutually beneficial and collaborative relationship between the business and its suppliers. Supplier relationship management should focus on choosing the best suppliers and also on managing them to develop a long-term relationship with them based on shared goals and mutual trust. The best advantage of AI-driven supplier management is segmenting the suppliers., This will help businesses categorize their suppliers based on factors such as strategic management, value contribution, risk exposure, etc. (Carr and Pearson, 2002). Businesses should follow these initiatives to allocate their resources effectively and to enjoy better and steady supply chain resilience.

VII. FUTURE OF AI IN SUPPLY CHAIN PLANNING:

The last two decades have seen a resurgence in the use of AI across diverse industries, and the potential of AI in various business functions is being explored in light of current needs and future goals. AI helps business systems to take insights from data without human input. With the help of AI, organizations are able to identify weak points in their supply chain management and allocate their resources wisely (FossoWamba and Akter, 2019). By extracting the expectations of clients rapidly, appropriately sensing the market, utilizing the failure modes, and optimizing the internal and external supply chains, AI has the potential to help businesses build the best goods possible (Jabbour et al., 2020).

Industries have steadily uptaken AI, and it has undergone a different level of resilience after the COVID-19 scenario (Zouari et al., 2021). Customers in the modern corporate world want supply chains to offer customized solutions and reliability. In recent years, there has been a rise in the practice of applying AI techniques to the simulation and modeling of complex systems in supply chain management and to improve performance from a lean and agile perspective.

VIII. MARKET GROWTH OF AI IN SUPPLY CHAIN

AI in the supply chain was valued at a global market rate of USD 5.05 billion in the year 2023. This trend is, however, expected to grow at a CAGR of 38.9% between the years 2024 and 2020. We can attribute this growth to the adoption of artificial intelligence in all of the supply chain mechanics. AI optimization helps improve the operational efficiency of supply chains. It also renders greater visibility for businesses in the supply chain operations. The market value of AI in the supply chain is expected to reach an estimated USD 64.28 billion by the end of the year 2032.

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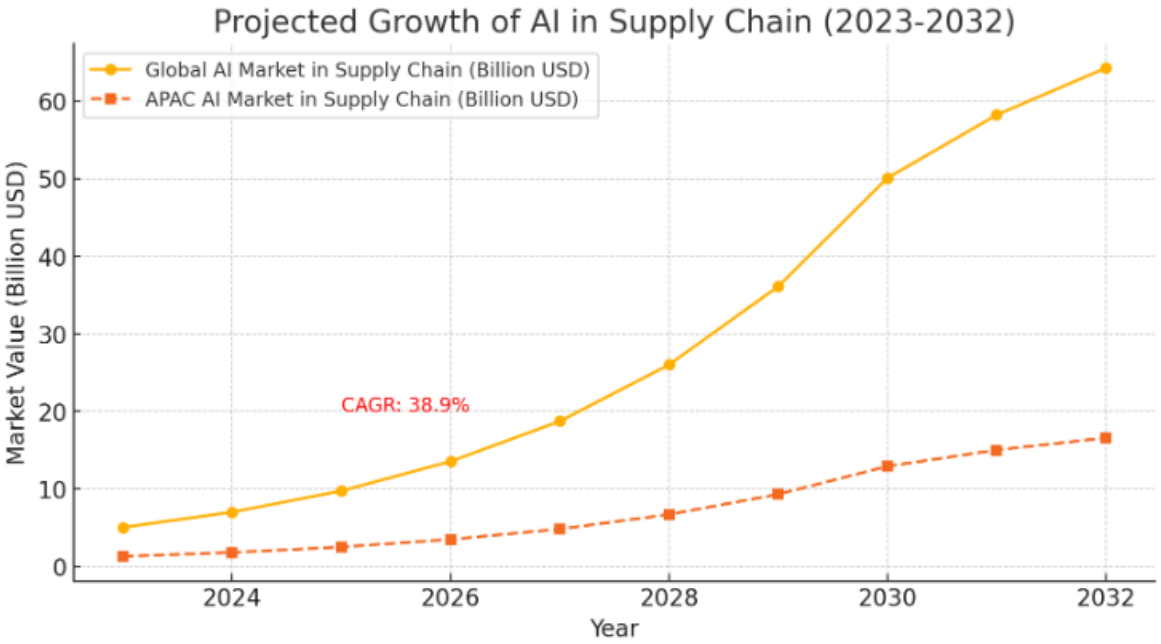

Figure 5: Projected growth of AI in supply chain

The Asia Pacific region alone contributed towards the growth of 25.8% of the global AI in supply chain revenue in the year 2023. We can expect this value to grow up to USD 15.39 billion by 2030. Such rapid growth is driven by technological advancements and the increasing volume of data generated within supply chains.

1. By 2028, it has been anticipated that Generative AI models will power 25% of the KPI reporting in the supply chain.
2. Businesses that have incorporated artificial intelligence techniques in their supply chains have experienced 15% less logistics costs and also a better improvement in their inventory levels of up to 35%.
3. AI suggests proactive measures for businesses to help them anticipate and also reduce disruptions in their business processes.
4. With the integration of artificial intelligence with Internet of Things sensors and cloud computing platforms, it is possible to achieve insights on-time data collection, data processing, and analysis. This enables AI to make informed decisions and offer greater agility within the supply chain.
5. AI algorithms predict demands accurately with the help of historical data and by studying market trends. They also allow predictive analysis to foresee and mitigate potential disruptions.

IX. RECOMMENDATIONS

1. Predictive analytics: Companies should invest in AI-driven predictive analytics to forecast demand variability and supply disruptions accurately.
2. Supply chain resilience: Logistics companies should implement AI to build resilient supply chains that track global events and economic conditions in order to independently source production methods and logistics.
3. Digital twin technology: Digital twin technology for creating virtual replicas of the supply chain and the integration of IoT sensors will lead to enhanced transparency across logistics and warehouse operations.
4. Robotic process optimization: Implementing RPA to automate procurement order fulfillment and supplier contracts, in addition to using drone and autonomous vehicle delivery options, will support an efficient last-mile delivery option.
5. Demand Sensing: AI-enabled demand sensing techniques will uncover signals of change in consumer behavior, allowing for the timely optimization of inventory levels.

X. CONCLUSION

Supply chain management is experiencing one of its most transformational events of all time, with artificial intelligence at its core. This is now providing openings, unprecedented in the past, for reductions in cost, increases in efficiency, and improvements in performance throughout the entire supply chain. From demand forecasting through improving inventory to optimizing replenishment orders, the AI algorithms adopted in the supply chain will empower businesses to derive actual data-driven insights for business process streamlining and decision-making. As global supply chains continue to evolve on their complexity, AI will play a pivotal role in driving its competitive advantage. Businesses that embrace this transformation will be better positioned to handle its processes in a resilient and sustainable way. In addition, AI will foster better decisions in supply chain planning through the inclusion of numerous constraints, risks, and real-time opportunities associated with decision-making.

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