Artificial Intelligent Enabled Supply Chains as a Competitive Advantage

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Abstract

The focus of this paper is on the topics of artificial intelligence and supply chain management and how artificial intelligence-enabled supply chains provide organizations with competitive advantages. The supply chain's adoption of data collection technologies as part of digital transformation and movements of industry 4.0 creates a strong foundation for artificial intelligence analytics. Artificial intelligence has three branches sensing and interacting, decision-making, and learning. Each branch uses its algorithms and serves a different purpose for the business. Artificial intelligence-enabled supply chains create unique, inimitable competitive advantages that fit Michael Porter's five forces.

Artificial Intelligence Enabled Supply Chains as a Competitive Advantage

The business world is constantly changing, with relevant and vital events occurring. Many of these events have impacted companies' supply chain networks. For example, COVID-19, the blocking of the Suez Canal, rising inflation rates, and consistent shifts in customer demand. These events are causing business leaders to reassess their companies and understand new ways to tackle them. Supply chain management is a relatively new concern for companies. Schlegel and Trent explain that companies historically focus on financial and legal risks in their 10K risk assessments. However, many of the company's risks have been concerned with their supply chains (Schlegel & Trent, 2015). Companies must utilize their supply chains to mitigate these risks, combat new challenges, and create unique advantages. Supply chain managers must move quickly and find new sources of sustainable competitive advantages as companies are looking to restructure their operations. One way this can be achieved is through leveraging new technologies.

Industry 4.0 has become a major force in shaping the future of business through data and technology. This new era has introduced various technologies that companies can harness to create new procedures and advantages. IoT, blockchain, and big data are just a few examples (Queiroz et al., 2021). These technologies optimize processes and develop stronger companies through the use and creation of data. Data is one of the most effective business tools in the twenty-first century. Data is the backbone of advanced analytics and artificial intelligence; companies can create powerful insights, increase visibility, improve quality, and reduce risk (Marr, 2022). These develop advantages for companies to remain competitive in today's marketplace. The thesis will explore supply chain management and technologies, what artificial intelligence is and how it works, current developments in artificial intelligence and digital

technologies, and how companies can leverage these technologies to create competitive advantages.

Supply Chain Management

What is Supply Chain Management

A logical place to start is by explaining what supply chain management is. Donald J. Bowersox is a prominent author on supply chain management. His work has been published in various honorable publications, and he is considered the "Grandfather of Supply Chain." He wrote ten textbooks and over 250 articles on marketing, transportation, and logistics. In addition, Bowersox was a member of various prestigious supply chain editorial boards (Michigan State University, 2011). Bowersox describes supply chain as effectively and efficiently integrating suppliers, manufacturers, and retailers to deliver the right products, in the correct quantities, to the right people, to the right locations, at the right time, to minimize costs and achieve customer's desired value (Bowersox, 2020). Bowersox's foundational definition emphasizes the importance of order accuracy, quality, and efficiency by connecting all parts of the supply chain network. For the *perfect order* to occur, the right product gets to the right place in the right condition at the right time (Bowersox, 2020). For this to be fulfilled, all the movement of materials and orders must be seamless. Kte'pi explains supply chain management as overseeing the business providing a product or service through all stages, from raw materials to final purchase (Kte'pi, 2009). Oversight requires strong communication channels and even stronger channels for information flow. Supply chain management is concerned with the flow of both materials and information. Helo and Hao (2022) explain that supply chain managers aim to fulfill customer demand, improve responsiveness, and create a network among stakeholders. These

goals show that information is key to supply chains because of the need for transparency and visibility, ultimately translating to tangible value for consumers.

Current Events in Supply Chain Management

There have been a variety of events that have caused companies to reevaluate how their supply chains need to operate. These events have caused major disruptions and shifted corporations' understanding of how technology can make these impacts. By establishing new procedures to prevent risk, companies can react quickly to shifts in demand, have alternate contingency plans if risks are realized, and forecast for when unforeseen events may occur (Schlegel & Trent, 2015). COVID-19 is a primary example of a case study on how these major risk events can be mitigated through technology.

COVID-19 completely altered companies' approaches and views of how supply chains need to operate. The global pandemic began in 2019, but the effects are still being felt today. 94% of companies in the United States experienced supply chain disruptions (Black & Glaser-Segura, 2020). These companies needed to reassess how they dealt with supply chain forecasting, resiliency, and partnerships. Technology is a key contributor to solving these issues. Srivastava found that digitization and agility were the two largest man contributors to reducing risk and outlined the importance of focusing on emerging technologies, taking advantage of advanced supply chain predictive analytics, and the ability to respond to real-time demand (Srivastava, 2022). Each of these focus areas can be supported by using and implementing artificial intelligence-enabled supply chains. As companies build stronger technology-enabled supply chains, they can mitigate the impact of risk and remain more competitive.

Current Trends in Supply Chain Management

Supply chain management is a discipline that is consistently changing and growing. Supply chain management is directly correlated with technology advancement and how companies can utilize technology to optimize processes, become more efficient, and protect themselves from risk. The Association for Supply Chain Management and Gartner are our two central bodies of research for the supply chain field. They both published articles about the main trends in supply chain management (ASCM, 2023; Gartner, 2023). After analyzing the reports, all the trends overlap and can be divided into three broad categories: increase supply chain data and analytics, further or develop digital supply chains, and enhance risk management.

Increased Supply Chain Data and Analytics

The importance of data businesses must be discussed to understand the importance of supply chain analytics. Data comes from various sources, including documents, conversations, and machinery (Marr, 2022); it is at the fingertips of every business leader. Companies can begin to tap into these data pools by utilizing new technologies. Marr explains four primary use cases for data in an organization. Data improves decision-making, enhances understanding of customers and markets, helps organizations create better products and services, and improves overall business processes (Marr, 2022). Data allows companies to make more accurate decisions without second-guessing themselves. Analyzing data increases supply chain visibility, efficiency, and response time (Ivanov et al., 2021). The Association for Supply Chain Management encourages supply chain leaders to utilize big data and analytics to mitigate disruptions and increase predictability and agility through descriptive and prescriptive analytics (ASCM, 2023). Predictive and descriptive analytics are components of artificial intelligence that have changed how companies utilize their data. Artificial intelligence has a wide range of capabilities that can

be utilized to take advantage of these trends because various artificial intelligence algorithms are built on predictive and prescriptive analytics. With the increased visibility of data analytics, artificial intelligence technologies can identify trends and patterns to improve forecast accuracy (Ivanov et al., 2021).

Digital Supply Chains

Digital supply chains allow companies to have a fully visible integrated supply chain. High levels of technology and connectivity let companies track their product's location and status through a fully connected system. According to Queiroz et al. (2021), digital supply chain capability refers to a range of information and communication technology (ICT) resources that enable organizations to digitize their physical activities and integrate them with digital processes. Integration minimizes resource consumption, enhances productivity, and improves network visibility while providing real-time feedback. To support these capabilities, organizations need to adopt robust data management techniques (Queiroz et al., 2021). Digital supply chains are focused on technological applications. The Association for Supply Chain Management explains that successful digitized supply chains require large-scale sensor implementation via IoT, digital twins, and shared internal/external interfaces (ASCM, 2023). These technologies provide a full view of the company and its suppliers and require high trust since sensitive data is shared. Digital supply chains truly alter how companies understand themselves and analyze the problems they endure. A fully digital supply chain will have a digital twin. Digital twins give full visibility and analyze risks, KPIs, and supply demands (Koshulko, 2022). Managers are flagged when something goes wrong in one of these areas. Digitization provides new levels of information and assistance for supply chain leaders.

Enhanced Risk Management

Risk management is an essential topic for supply chains. Over the past several years, major risk events have occurred, ranging from pandemics to wars. Ninety-four percent of companies in the United States experienced supply chain disruptions (Black & Glaser-Segura, 2020). These risk events put major stress and pressure on companies' supply chains. Schlegel and Trent (2015) defined risk as the likelihood of unintended consequences leading to loss, injury, or missed opportunity. As explained, the risk is not always a harmful event. Missed opportunities serve as an example of a non-harmful risk event. These events resulted in companies needing more support to meet increasing demand due to manufacturing restrictions (Schlegel & Trent, 2015). Risk management is focused on mitigating the negative impacts of fast-moving and unexpected risks. The key to supply chain risk management is to enhance resiliency and improve competitiveness (Gartner, 2023). Companies that can better predict, understand, and reduce risk impacts will be more successful. ASCM says companies that can mitigate adverse events faster provide excellent customer service, generate value, and increase market share (ASCM, 2023). Technology can be used to improve companies' approach to managing risks. Technology can signal risk events (Olivares-Aguila & Vital-Soto, 2021). The warnings of these events allow supply chain leaders to step in and reduce the impact of the risks. When building risk response road maps, signal monitoring through digital twins is essential (Olivares-Aguila & Vital-Soto, 2021). Digital twins utilize predictive and prescriptive analytics to understand risks and improve resiliency (Ivanon et al., 2019).

Supply Chain Technologies

Companies must tap into essential technologies to collect data to improve their supply chains. Technology allows companies to optimize their processes and streamline data

management. The Supply Chain Dive analyzed the MI Annual Industry Report, where over 1000 supply chain professionals were surveyed about technologies that are tangibly changing their supply chains. The report begins to identify some technologies as the "revolutionary stage," laying the foundation for four innovations we are seeing today. The first group of technologies would be the next step for companies to begin to capture data and lays the framework for data analysis. Magil and Lopez (2022) discussed inventory optimization tools, cloud computing and storage, and IoT technologies like sensors, robotics, and automation. These technologies have been grouped together due to their decreased adoption rates over the next several years. The decreased adoption does not mean they are less important but show that they are the foundations for the next principles.

IoT and Inventory Optimization Tools

IoT is the technical backbone of all of Industry 4.0 (Colli et al., 2021). IoT is centralized to monitor, control, and understand the business. IoT technologies build deep ties between the customer and the company (Siggelkow & Terwiesch, 2019). In supply chains, installing sensors and automatic identification will better equip companies with an understanding of where their packages and products are in their distribution center. IoT technologies can be simple camera red eye sensors or RFID tags (Miller, 2021). IoT can also include connecting machinery and robotics to an ERP system. Machinery will also be able to share information with the system about package status or machine status updates. Increasing integration will give the company a better-developed digital replica of its processes (Koshulko, 2022). Digital twins allow the organization to improve processes and use more advanced optimization tools to analyze the data they record.

Inventory optimization tools can be add-ons to ERP systems that allow for demand forecasting or software that runs different simulations through digital twins. Inventory

optimization tools utilize information from IoT devices and POS systems to understand the movement of goods throughout the supply chain and the consumers' current demand. ERP and optimization systems can recognize trends and consumer spending and inform organizations to produce more of a particular product (Miller, 2021). They can be utilized to run simulations where a supplier cannot provide goods and provides recommendations on the next steps. IoT technologies will be built to help support ongoing operations and improve decisions.

Cloud Computing and Storage

Cloud computing shifts the organization to the cloud and allows organizations to share information with their supply chain partners. Shifting technologies to the cloud enables organizations to begin a control tower approach where there is one central location where decisions are made, and information is stored (The University of Tennessee Knoxville, 2020). Cloud computing and storage create more efficiency when the whole organization is on the same page, interacting and working together (Pierce, 2020). A shift to cloud servers means organizations no longer have documents in different departments. Companies will no longer fall to the siloed effect where people need to communicate, and information is lost by not being stored in a central location. Cloud technologies are the core of the supply chain ecosystem (Wilson, 2021).

IoT, inventory optimization, and cloud computing lay the foundations for more advanced technology that large organizations are adopting. *The Supply Chain Dive's* analysis of the MHI report shows how companies are looking into adopting more advanced technologies. These technologies are the next era of innovation, artificial intelligence, blockchain, and predictive/ prescriptive analytics (Magil & Lopez, 2022). AI technologies provide highly competitive advantages for organizations because of their ability to utilize data. Artificial intelligence and

machine learning algorithms analyze data to create recommendations and identify patterns to create insights helping users better understand what is happening in the organization (McKinsey, 2023). They take data and look beyond what can be seen at the surface. They can develop charts and diagrams to help inform the organization to make database decisions to improve their processes. Blockchain alters our understanding of record keeping and securitization of documents (Miller, 2021). Blockchain assists in managing contracts and financial transactions (The University of Tennessee Knoxville, 2020). Record keeping for banks, medical health records, and importing and exporting contracts can all be greatly impacted using blockchain technology. Supply chain technologies rapidly develop and have a bright future affecting how supply chain managers approach data and technology.

Future of Supply Chain Technology

Technology is going to continue developing. Gartner explored the future of supply chains and the importance of some of these technologies. Hippold explains what technologies will look like in 2022 and beyond. The first prediction they make is that by 2026, 75% of large companies will have intralogistics small robots (2022). The major shift in robotics will utilize their digital facility layouts and move robotics along the most efficient routes. The University of Tennessee Knoxville (2020) claimed that autonomous mobile robots (AMR) would help increase the efficiency and automation of warehouses. Autonomous mobile robots will shift employees from pushing tubs and collecting ballots to more value-add positions. Robotics allows organizations to be able to move employees to more value add positions. Robotic process automation can be used on repetitive tasks with better performance (Wilson, 2021).

One example of an organization that utilizes robotics is Amazon. Amazon has warehouses that are mostly operated by robotics. Their e-commerce empire is supported by a

whole fleet of robotic assistants. Robotic innovation began with the purchase of Kiva in 2012 (Wessling, 2022). The kiva purchase has allowed them to unveil Proteus, the first fully autonomous mobile robot (Amazon Staff, 2022). The automated system, Proteus, efficiently collects and transports batches of goods around the warehouse. Robotics assistance goes beyond moving racks and includes packing, sorting, and storage (Amazon Staff, 2022). Amazon is consistently looking to innovate and integrate robotics.

DHL Logistics is another organization that utilizes a vast amount of robotics. DHL logistics partnered with Locus Robotics to expand their automation. In 2022, DHL utilized 2,000 robots to pick over 100 million units in their fulfillment facilities (Magill, 2022). Increased robotics allows DHL to handle increased e-commerce demand. In addition to Locus Robotics in warehouses, DHL has incorporated two new sortation machines that can sort more than 1,000 pieces an hour (Magill, 2022). It would require several associates to match the same level of speed that the new machines operate at. By utilizing robotics, DHL has been able to handle increased demand with great efficiency without exhausting current associates.

Another prediction made by Gardner is that by 2026, 75% of all large supply chain management app vendors will likely have advanced analytics and artificial intelligence (Hippold, 2022). These developments will make advanced analytics and AI more available to companies. So, companies need to begin building the framework for the upcoming technologies. Framework development begins with organizations taking control of their digital transformation initiatives and recognizing the power of big data (Marr, 2022). Using big data and advanced analytics in artificial supply chain leaders can create end-to-end visibility and improve the execution of decisions (The University of Tennessee Knoxville, 2020). Connecting these two initiatives pairs business leaders with technology leaders and takes enforces the use of data throughout the

organizations. Supply chain application vendors must improve their applications to integrate artificial intelligence, machine learning, and cloud technology (Wilson, 2021). Supply chain software needs to combat the constantly shifting demand of customers. For example, UPS utilizes Harmonized Enterprise Analytics tool to capture data, plan, and track the real-time status of every package (Olavsrud, 2022). The system allows UPS to improve the way they manage packages and data to pass more information to their customers. The system leverages predictive analytics, machine learning, and forecasting (Olavsrud, 2022). The HEAT platform utilizes data to create strategies for the organization. Organizations must develop strong data plans in order to reap the immense benefits of advanced analytics.

The last prediction is the most astonishing, through 2026, 80% of companies will suffer a significant loss of value due to failure to merge their digital supply chain with their control tower initiatives (Hipplod, 2022). Companies must begin moving with technology and look forward to the future. Without the proper use of technology, an organization will be unable to effectively execute control tower change management (Guddati, 2018). Systems need to be able to show real-time data to make effective decisions; legacy systems have a high level of latency that leave managers unable to make effective data-based decisions.

Gartner comes out with a yearly hype cycle explaining emerging technologies' status. They identify three trends that are coming up the technological pipeline. Evolving immersive experiences accelerated, artificial intelligence models, and optimized technologist delivery (Perri, 2022). The technology associated with these trends may be less relevant for another five years, but business leaders need to know where the world is moving. New technologies like digital twins of customers, decentralized identities, generative AI, and cloud data ecosystems will completely alter how major organizations run (Perri, 2022). These technologies are all

centralized around data that companies can harness. It is time for businesses to take data seriously, or else they will not be able to compete. The future of business is data.

Artificial Intelligence

What is Artificial Intelligence?

Artificial intelligence has experienced significant growth in the past few years. Technology breeds innovation, new business models, and stronger market share. As technologies continue to grow, companies need to keep in stride and adapt to innovations. Integration of new technology can result in leaders in the marketplace (Cortellazzo et al., 2019). All companies must learn how to integrate the new movement of artificial intelligence. Supply chain leaders need to understand what artificial intelligence is, how it works, and current developments in the field.

Artificial intelligence was coined in 1955 by John McCarthy. McCarthy's idea was centralized around making "machines behave in ways that would be called intelligent if a human were so behaving" (McCarthy, 1995). The idea of artificial intelligence is more focused on making machines think and providing new ways of thinking and learning. Intelligence is centralized around acquiring and applying knowledge and skills. Having computers programmed to perform intelligent behavior requires a high level of calculations. Truing popularized artificial intelligence in the paper "Computing Machinery and Intelligence." He developed the Truing Test, which focused on having computers calculate things we could never imagine doing to see what results could come from it (Cope et al., 2021). By performing these in-depth calculations, computers can provide new insights into data that were never thought feasible or recognizable. These calculations are intelligent behavior that can be used to create thoughtful decisions. Cope raises a thoughtful question about the connection between binary calculations and human

meanings (Cope et al., 2021). The conversion from numbers to insights is what creates intelligence. There will be no significance if the information is just presented as a series of numbers on a spreadsheet. Artificial intelligence develops meaning through a series of analytics and algorithms. Reilly et al. (2003) explain artificial intelligence as creating intelligent artifacts through the computational understanding of data. Intelligent artifacts, or pieces of new knowledge, result from creating new knowledge. As companies look to embark on the creation of artificial intelligence, there have been limitations, such as the need for computing abilities and quality data.

The Development of Artificial Intelligence

Artificial intelligence's major growth and development have occurred rapidly over the past few years. McKinsey states that the growth of artificial intelligence is due to the convergence of three major trends: algorithmic advancements, the explosion of data, and exponential increases in computing power and storage (McKinsey, 2023). Combining these three trends allowed companies to quickly develop new and more advanced artificial intelligent devices and software. Helo & Hao go into more detail on similar shifts have affected the development of artificial intelligence. The first key development is increased data from sensors, transactions, and operations (Helo & Hao, 2022). The increased data does improve not only the insights that artificial intelligence can provide but also the accuracy of their assumptions. For example, in supervised learning, the more data companies have, the more they can train and strengthen their algorithms. The second shift is to improve cloud infrastructure and computing power (Helo & Hao, 2022). The infrastructure allows companies to store and process more data without running into internal server restrictions. These two trends have led to the development of

more advanced and efficient AI systems. Combining McKinsey Helo & Hao's trends has created the perfect storm for artificial intelligence to grow and develop.

Over the past few years, artificial intelligence has had major expansions. With artificial intelligence's exponential growth, Cope says to "focus on the less and leverage the more" (Cope et al., 2021). It is hard to keep up with AI's rapid development and constant innovation, instead of attempting to master every new algorithm. Focus on specific artificial intelligence types that add the most value to the organization. As the Pareto principle explains, companies must focus on the 20% of their business processes that create 80% of the results. After adopting that mindset, companies can look at their value stream maps to see where artificial intelligence can impact their organizations most.

How Does Artificial Intelligence Work

Organizations must understand how these systems work to reap the benefits of artificial intelligence. Since artificial intelligence harnesses a wide range of data and has many uses, it works in a few different ways. Pournader et al. (2021) artificial intelligence has three main categories: sensing and interacting, decision-making, and learning. Each of these categories has specific uses and works differently.

Sensing and Interacting

Sensing and interacting artificial intelligence systems are more relational than the other types. These systems are extremely helpful to users and are built on vision, speech recognition, and natural language processing algorithms (Pournader et al., 2021). Sensing and interacting systems can be used for image recognition, text-to-speech, and voice-based assistants. Of the three, natural language processing is advancing the most. Natural language processing solves cognitive problems using speech recognition to interpret data and respond appropriately (de

Barcelos Silva et al., 2020). Some common examples used by people today are Amazon Alexa and Google Home. These systems work by extracting text and classifying it to answer questions. Voice-based picking systems can utilize natural language processing in supply chain warehouses. An example of voice-based picking is when an employee wears a headset and confirms shipments or picked items. They have been proven to have the lowest error rate compared to traditional picking options (Sheriff & Aravindhar, 2022).

Decision-making systems

Decision-making systems are used for simulations and modeling; optimization; planning and scheduling; and knowledge-based systems (Pournader et al., 2021). These systems come alongside humans and work with them. Decision-making systems focus on automating highly formalized tasks (Haenlein & Kaplan, 2019). By automating simple tasks, companies can focus on using human intelligence in more value-add positions. Automation is fulfilled by using algorithms to collect labeled data and output plans, schedules, or advanced models. The algorithm is built to streamline and optimize the process. A decision-making system can also be set up to run scenario analysis to enhance decision-making (Moaykedikia et al., 2020). Scenario analysis allows the company to run simulations and understand the outcome of potential plan adjustments.

DHL is a perfect example of an organization that utilizes decision-making systems in its supply chain. Data is acquired through devices, robots, and sensors and is centralized in their warehouse management system. The system then utilizes algorithmic analysis to optimize resources and tasks by providing DHL with optimal routes, best locations for inventory in the warehouse, and defines transportation routes (DHL, 2023). DHL's system allows the organization to optimize planning and decision-making in their organization.

Machine Learning

Machine learning systems are one of the more prevalent approaches to artificial intelligence. Machine learning is the core of artificial intelligent behavior. Machine learning is associated with developing algorithms that can learn by training data to solve problems using knowledge from previous problems (Priore et al., 2019). Algorithms only become more intelligent through training and testing with more data sets. New knowledge is created using descriptive, predictive, and prescriptive analytics (McKinsey, 2023). Most machine learning is focused on leveraging predictive and prescriptive analytics to forecast potential events or fin core aspects of data sets. New knowledge is created through three general types of machine learning, supervised, unsupervised, and reinforcement learning (Cui et al., 2018). Each of these types of learning has different use cases and algorithms.

Supervised learning develops an algorithm to identify the relationship between identified inputs and outputs. The process works by entering labeled data and a defined output variable. An algorithm is then developed to connect the two. The new algorithm can now be applied to new data sets (McKinsey, 2023). Supervised learning systems take a variety of inputs and develop an algorithm to connect them to one desired output. Algorithms that are used are typically classification and regression techniques. These systems are typically used for pattern recognition and prediction (Sen et al., 2022). By identifying patterns in data sets, supervised learning systems can understand drivers for product sales, classification of types of customers, and predict the likelihood of increased demand or system malfunctions.

Unsupervised learning differs from supervised learning because the inputs and outputs are not defined. These systems look to classify data and identify patterns. Unsupervised learning models deduce the hidden structures or relationships in the dataset (Sen et al., 2022). Then forms

clusters with similar characteristics and behaviors (McKinsey, 2023). These systems require much training as algorithms are created through tests. Unsupervised learning utilizes various clustering techniques and reward-based problems in its algorithms (McKinsey, 2023; Sen et al., 2022). These systems identify customer segments and can make recommendations based on similar tastes and preferences or identify outliers in your customer base.

Reinforcement learning is the last main type of machine learning. These systems are built on a series of feedback loops. Reinforcement learning focuses on understanding the environment and how to interact with it. The system utilizes an algorithm to perform a task and receive rewards if it is closer to maximizing the total rewards (McKinsey, 2023). The feedback after the task improves its performance through trial and error (Pournader et al., 2021). The process should be used if a limited amount of data is available to train the algorithm (McKinsey, 2023). Reinforcement learning can improve stocking and picking in warehouse robotics and optimize load capacity in various systems.

Machine learning is one of the main ways that systems are considered intelligent. The purpose of machine learning is to develop more intelligent systems. Walmart utilizes machine learning in its supply chains to help solve a variety of problems and optimize processes at a global level. Walmart's advanced artificial intelligence and machine learning algorithms help them anticipate demand cycles, trends, and seasonal products (Torres, 2022). Algorithms create new insights and recommendations through supervised, unsupervised, and reinforcement learning and automate tasks. None of the artificial intelligence categories sensing and interacting, machine learning, and decision-making, stand alone. These systems work together to create the discipline of artificial intelligence. AI can only be achieved with data acquisition, processing,

and analytics. Companies need to learn the importance of data and how technology is the foundation for the artificial intelligence movement.

Developing Artificial Intelligence-Enabled Supply Chains

A Company Using Artificial Intelligence in Supply Chains

With proper data acquisition and processing, companies can reap the benefits of artificial intelligence. Organizations have been looking to adopt new technologies to assist with the recording and processing of massive amounts of data. One of the main areas companies have been able to start this process is their supply chain networks. The first company that is considered when looking into artificial intelligence is Amazon. Amazon utilizes artificial intelligence across almost all its business functions in the flywheel approach, where an organization makes small iterative changes, creating momentum for larger continuous changes (Marr, 2021). From predictive analytics for demand forecasting to robotic warehouses to automate tasks, Amazon does it all (Garland, 2022; Hall & Degen, 2023). Amazon has dominated the e-commerce market by predicting customer demand before they even know they want it. Amazon's three main areas where artificial intelligence is used are its recommendation engine, Alexa, and Amazon Go Store (Morgan, 2018).

Amazon's recommendation engine is strengthened through its partnership with IBM Watson. They can move products to distribution centers closer to customers by tracking data (Cui & Wang, 2022). Predictive analytics has allowed them to provide Amazon Prime's lighting fast shipping and directly advertise products on their Amazon accounts. Their ability to make data-based decisions through machine learning fueled high levels of customer service (Petiwala et al., 2021). Their recommendation system utilizes data from customer preferences, browsing history, and recent purchases and generates thirty-five percent of Amazon's revenue (Morgan,

2018). Amazon has redefined how companies need to approach technological and artificial intelligence advancement in their company.

Alexa is a personal assistant that can help in a variety of ways. Through Alexa's natural language processing system, Alexa can be utilized by small companies to help automate tasks like ordering new inventory and equipment. Alexa is designed to have several add-ons to automate other tasks like printing shipping labels (Kaplan, 2019). Amazon's data acquisition through Alexa improves the its ability to understand consumers' wants and needs. Therefore, Amazon will be able to recommend new products for them to buy better.

Amazon Go store utilizes a variety of artificial technologies to improve the customer experience. The store offers a unique experience where they will not need to check out. In-store cameras and computer vision allow customers to shop and just walk out of the store (El, 2018). All of the products in the store are placed on weighted sensors, and when the items are removed, cameras scan your face and put the same item in your Amazon cart. When the customer leaves the store, their card is automatically charged (Amazon, 2023). This fully automated experience utilizes artificial intelligence's full capabilities.

Artificial Intelligence Integration with Supply Chains

There is such a wide range of capabilities that organizations can use artificial intelligence to increase their supply chain networks. Companies like Kroger, Chipotle, Amazon, and Levi are making these advancements (Garland, 2022; Littman, 2022; Ruggles, 2022; Wells, 2022;). These companies are utilizing new technologies like RFID tracking, robotics, AI Enterprise Resource Planning (ERP) systems, and more to advance their supply chains' transparency, speed, and reliability. Companies looking to compete in Industry 4.0 must keep up with developments in digital transformation to achieve new AI capabilities.

Artificial intelligence comes from the proper integration of an organization's technologies and the data that is recorded. Artificial intelligence's fundamental characteristic is the ability to process information and create something new with it (Kte'pi, 2009). Once supply chain leaders can understand the need for data management, their perspective can change from supply chain management from solely focused on the movement of materials to the flow and movement of information. The shift in view is why the whole supply chain industry emphasizes digital transformation's importance. Digital transformation can be seen as a major overhaul for some organizations, but in the simplest sense, it focuses on enhancing flexibility with the existing digital infrastructure (Ivanon et al., 2021). Supply chain networks already have an existing format to transfer and move information, but these systems often need to be connected (Agrawal et al., 2019). As companies integrate their supply chain information systems, they can increase their visibility and transparency across the organization (Quieroz et al., 2021). Once companies can begin this process, they should also look to spread digital transparency to their external stakeholders. The more data can be harnessed, the more accurate their artificial intelligence insights will be.

Helo and Hao (2022) explained the type of data that can be harnessed in supply chains and how artificial intelligence can be applied. Order data can forecast demand, RFID tracking can increase transparency, temperature sensors can trigger condition-based maintenance, and cameras can automate quality control (Helo & Hao, 2022). These data sources can utilize artificial intelligence to improve supply chain operations. In addition, the more data from various sources, the more artificial intelligence capabilities they can integrate. As seen, a wide variety of applications for artificial intelligence create strong, unique advantages for organizations. For these to be achieved, core technologies need to be in place.

Leveraging Artificial Intelligence in Digital Supply Chains

Core AI Technologies For Digital Supply Chains

The core of artificial intelligence advancement stems from an organization's ability to use technology to gather data. Therefore, organizations need to understand what technologies will assist in collecting and analyzing information. Kaplan (2018) explained how corporations could develop and leverage an intelligent supply chain. He explained four levels of intelligent supply chains: level one real-time end-to-end visibility, level two AI recommendations, level three AI-driven predictions, and level four autonomous actions (Kaplan, 2018). At each level, companies utilize new AI capabilities built off technology from a fully visible supply chain. Supply chain visibility is essential in developing digital supply chains (Gartner, 2022). Gartner developed a three-step plan to develop digital supply chains. Companies must embed their supply chains in a digital ecosystem, implement autonomous supply chains to predict demand and automate tasks, and synchronize digital supply chains to identify gaps, obstacles, and vulnerabilities (Gartner, 2022). Digital and intelligent supply chains start from the foundation of developing end-to-end visibility in a digital atmosphere. End-to-end visibility must be an initiative for the organization and its suppliers.

Digital Supply Chain Data Collection

The first development phase would be to build out ERP systems to connect the organization with its suppliers (Quieroz et al., 2019). By doing so, companies will be better able to coordinate with their partners and see the data they are collecting. Full transparency with suppliers requires a high level of vulnerability and is hard to achieve because it requires a high level of trust, but essential for the full benefits of artificial intelligence technologies since it will act as a large data pool for all the information collected through IoT and cyber-physical systems.

To prevent organizations from hiding valuable data, there should be a cloud computing system for information to be shared by all members of the supply chain network (Agrawal et al., 2020).

IoT technologies allow companies to enhance the value of shared data because of real-time visibility (Ivanov et al., 2021). These IoT technologies track and detect the movement from suppliers across the distribution center to the customers through sensors, cameras, and RFID tags. Cyber-physical systems will also provide valuable data from the distribution center (Quieroz et al., 2019). These machines automate processes and communicate with one another within the distribution center (Salam, 2019) and provide insights into machine status and productivity. Integrating IoT and cyber-physical systems allows organizations to monitor and fully enhance control over operating systems. After organizations implement these systems within their organization, they should look to extend these technologies to their suppliers, increasing the span of their end-to-end visibility.

Leveraging Artificial Intelligence

Data collection and visibility from end-to-end allow organizations to benefit from artificially intelligent algorithms. The algorithms that are utilized are only as good as the data that is put into them. The data must be accurate and real-time to benefit the organization (Fosso Wamba et al., 2022). Artificial intelligent systems can help benefit organizations in various ways. Artificial intelligence systems can help supply chains recommend actions based on historical actions. The systems can be used on machinery to recommend maintenance before it breaks down. Artificial intelligent systems can automate processes and run tasks, allowing people to be used in more value-added positions (Helo & Hao, 2022). AI-powered technologies can make efficient designs to eliminate waste, real-time monitoring, and error-free production, and facilitate lower process cycle times (Dash et al., 2019). By eliminating waste, errors, and

cycle times, supply chain networks will become leaner and can operate more efficiently using artificial intelligence.

Supply chain managers have much discretion on where they can choose to implement artificial intelligence. The implementation location may vary depending on the type of supply chain. Organizations must assess their supply chains through value stream mapping to identify common failure points or core competencies that need support (Olivares-Aguila & Vital-Soto, 2021). By utilizing value stream mapping, managers can protect their organizations from common risks and enhance and improve their core competencies. By improving core competencies, organizations may develop competitive advantages in their industries by utilizing artificial intelligence.

AI Supply Chains as a Competitive Advantage

Competitive advantages help a company achieve higher profits, increase market share, and stronger customer loyalty (Porter, 2008). Porter's foundations of competitive advantages align with Bowersox's explanation of supply chain strategy in cost minimization, value-add maximization, and control/ adaptability (Bowersox & Daughtry, 1995). Porter and Bowersox both focus on how organizations can be competitive in the marketplace and pass the most value to their consumers while being highly efficient. Organizations that want to obtain competitive advantages through their supply chains must be flexible, efficient, and effective (Bowersox & Daughtry, 1995). Supply chains that integrate artificial intelligence technology become more efficient through increased transparency and demand forecasting accuracy, flexible due to increased risk detection and response time, and effective through data-based decisions.

Artificial intelligence optimizes, automates, and improves how business is done. These various improvements will create advantages in the marketplace. Companies can leverage

artificial intelligence insights and automate tasks by integrating suppliers, processes, and data. Integrating suppliers through digital transformation, which is required for advanced analytics used in AI, increases the collaborative approach to risk management and mitigation. Artificial intelligent-enabled manufacturing can increase efficiency, cost savings, and customer satisfaction (O'Reilly, 2019). Increased levels of efficiency can also be attributed to artificial intelligence-enabled supply chains improving decision-making by providing real-time data and insights and increasing companies. Real-time data is built from stream processing rather batch processing, meaning that data has low latency and the most decent information can be seen without lag (Psaltis, 2017). Real-time data allows organizations to make more effective decisions by utilizing predictive and prescriptive aspects of artificial intelligence based on the most recent information. By understanding predictive analytics, organizations will be less likely to be responsive to fluctuating demand but more proactive in knowing what lies ahead (Younis et al., 2021).

Artificial intelligence and its variety of use cases in supply chain management create a variety of competitive advantages in today's marketplace. Younis et al. (2021) explain that artificial intelligence implementation can lead to unique and highly valuable resources that are difficult to replicate, providing a distinct advantage for organizations. Rare inimitable resources are exactly what Porter explains as competitive advantages. Porter has established a five-force framework for addressing competitive advantages: the threat of new entrants, the threat of substitutes, the bargaining power of suppliers, the bargaining power of buyers, and rivalry among competitors (Porter, 2008). From the assessment of this article, artificial intelligence-enabled supply chains create advantages in each of these areas. Artificial intelligence creates difficulties for new companies to enter the same market. With an increased understanding of customers, AI

organizations can create more personalized customer experiences reducing the threat of substitutes. Artificial intelligence also offers buyers and suppliers real-time data to negotiate better contracts and predict demand to improve inventory management. Finally, applying artificial intelligence in supply chains will reduce costs and increase efficiency, leading to competitive advantages over other firms in the same industry.

Conclusion

Artificial intelligence-enabled supply chains help corporations develop sustainable competitive advantages. Supply chain management offers a variety of avenues through that artificial intelligence can be applied. Planning, procurement, distribution, and logistics are just a few areas where artificial intelligence can be used. Supply chain managers must focus on more than just the movement of materials in their supply chains; the flow of data and information is essential to a resilient supply chain.

Supply chain resiliency has been a significant topic in business over the past few years. From pandemics to war, global supply chains have been tested and pushed to their limits. COVID-19, for example, caused many global supply chains to come to a complete standstill and resulted in product and people shortages. The massive disruptions have caused corporations to identify the most effective way to protect their supply chains. Supply chain research has shown that digitization and agility are the most effective ways of reducing the impact of major supply chain disruptions.

Supply chain managers also focus on data analytics, digital supply chains, and enhanced risk management. These major trends have pushed supply chain leaders to adopt new technologies to keep in step with new developments of Industry 4.0. Some of the major

technologies managers need to keep on their radar include IoT and inventory optimization tools, cloud computing, storage, and artificial intelligence.

Artificial intelligence focuses on programming machines to learn and develop new intelligence. These systems are built on various algorithms that help corporations by automating tasks, providing forecasts, and prescribing core issues. The increased data, advanced algorithms, and cloud computing and storage have created the perfect environment for artificial intelligence to grow and develop. Artificial intelligence is split into three main sections: sensing and interacting, decision-making, and machine learning. Each area highly depends on technologies that align with supply chain digital transformation.

As supply chains become more intelligent, they must implement digital information systems to integrate all business sections with their suppliers. From there, they should encourage data collection and analysis in all sectors. Data collection and analysis can be done by utilizing IoT and cyber-physical systems to collect and store the data on the cloud. Shared data pools allow organizations to analyze their data and utilize the full potential of artificial intelligence. When considering what data to analyze, managers should use value stream mapping to identify common failure points to protect or core competencies to enhance by implementing artificial intelligence analytics.

Artificial intelligence-enabled supply chains to optimize, automate, and control business processes. Implementation can result in cost savings, increased efficiencies, and unique customer experiences. These advancements are unique, rare advantages in the marketplace. Supply chain managers need to begin to take artificial intelligence seriously and adopt a culture of data collection and analysis. A culture of data collection and analysis allows companies to hold stronger competitive advantages. AI-enabled supply chains enable companies to decrease threats

of new entrants and substitutes, increase the bargaining power of buyers and suppliers, and increase rivalry against competitors.

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