

# The Role of Artificial Intelligence in Drug Distribution



Healthcare Distribution Alliance

## ABOUT THE HEALTHCARE DISTRIBUTION ALLIANCE

The Healthcare Distribution Alliance (HDA) represents primary pharmaceutical distributors — the vital link between the nation’s pharmaceutical manufacturers and pharmacies, hospitals, long-term care facilities, clinics and others nationwide. Since 1876, HDA has helped members navigate regulations and innovations to get the right medicines to the right patients at the right time, safely and efficiently. The HDA Research Foundation, HDA’s nonprofit charitable foundation, serves the healthcare industry by providing research and education focused on priority healthcare supply chain issues.



### ACKNOWLEDGMENTS

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## GLOSSARY

This glossary provides concise and active definitions for essential Artificial Intelligence (AI) concepts relevant to optimizing the healthcare supply chain (with relevant examples).

**Artificial Intelligence (AI)** – Artificial systems that perform tasks under unpredictable conditions without significant human oversight, learn from experiences, solve human-like tasks across various mediums, mimic human cognitive architectures and neural networks, employ techniques to approximate cognitive tasks and act rationally through perception, planning, reasoning and decision-making.<sup>1</sup>

**Black Box Models** – A system where the decision-making process is hidden and impossible to interpret.<sup>2</sup>

**Cold chain** – The uninterrupted process of maintaining end-to-end temperature-controlled conditions from the manufacturing site to the point of care.<sup>3</sup>

**Data Silo** – A collection of information isolated from an organization and inaccessible to all parts of a company hierarchy.<sup>4</sup>

**Deep Learning** – A subset of machine learning that uses multi-layered neural networks, called deep neural networks, to simulate the complex decision-making power of the human brain.<sup>5</sup>

**Digital Twin** – A virtual representation of an object or system designed to reflect a physical object accurately.<sup>6</sup>

**Last-/Final-Mile Delivery** – The delivery of products from the transportation hub to the end-users.<sup>7</sup>

**Generative AI** – Class of AI models that emulate the structure and characteristics of input data in order to generate derived synthetic content. This can include images, videos, audio, text and other digital content.<sup>8</sup>

**Internet of Things (IoT)** – All computing devices that are connected to the internet.<sup>3</sup>

**Leakage** – Capital or income that diverges from some kind of iterative system (for purposes of this discussion, used when a customer uses multiple vendors to provide the same type of services that could be supplied solely by one vendor).<sup>9</sup>

**Machine Learning (ML)** – A subfield of artificial intelligence the capability of a machine to imitate intelligent human behavior.<sup>10</sup>

**Reinforcement Techniques** – A type of dynamic programming that trains algorithms using a system of reward and punishment.<sup>11</sup>

**Supervised Techniques** – A machine learning approach that's defined by its use of labeled datasets.<sup>12</sup>

**Unsupervised Techniques** – Uses machine learning algorithms to analyze and cluster unlabeled data sets. These algorithms discover hidden patterns in data without the need for human intervention.<sup>7</sup>

<sup>1</sup> Office of Management and Budget. "Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence." March 28, 2024. <https://www.whitehouse.gov/wp-content/uploads/2024/03/M-24-10-Advancing-Governance-Innovation-and-Risk-Management-for-Agency-Use-of-Artificial-Intelligence.pdf>.

<sup>2</sup> IBM. "What is explainable AI?" May 2023. <https://www.ibm.com/topics/explainable-ai>.

<sup>3</sup> IQVIA Institute. "Pharma's Frozen Assets." January 2023. [https://www.iqvia.com/-/media/iqvia/pdfs/library/white-papers/iqvia-pharmas-frozen-assets\\_final.pdf](https://www.iqvia.com/-/media/iqvia/pdfs/library/white-papers/iqvia-pharmas-frozen-assets_final.pdf).

<sup>4</sup> TIBCO. TIBCO glossary. April 2024. <https://www.tibco.com/glossary/what-is-a-data-silo>.

<sup>5</sup> IBM. "What is deep learning?" June 17, 2024. <https://www.ibm.com/topics/deep-learning>.

<sup>6</sup> IBM. "What is a digital twin?" April 2024. [https://www.ibm.com/topics/what-is-a-digital-twin?mhsrca=ibmsearch\\_a&mhq=what%20is%20a%20digital%20twin](https://www.ibm.com/topics/what-is-a-digital-twin?mhsrca=ibmsearch_a&mhq=what%20is%20a%20digital%20twin).

<sup>7</sup> Cold Chain Packing and Logistics. "What is Cold Chain Last-Mile Delivery?" April 2024. <https://coldchainpacking.com/what-is-cold-chain-last-mile-delivery>.

<sup>8</sup> The White House. "Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence." October 30, 2023. <https://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/>.

<sup>9</sup> Investopedia. "Leakage: Definition in Economics and Examples." Last updated September 18, 2023. <https://www.investopedia.com/terms/l/leakage.asp>

<sup>10</sup> Massachusetts Institute of Technology. "Machine learning, explained." April 2021. <https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained>.

<sup>11</sup> IBM. "Five machine learning types to know." December 20, 2023. <https://www.ibm.com/blog/machine-learning-types/>.

<sup>12</sup> IBM. "Supervised vs. Unsupervised Learning: What's the Difference?" March 12, 2021. <https://www.ibm.com/blog/supervised-vs-unsupervised-learning/>.

## EXECUTIVE SUMMARY

As the need for prescription medicines sustains, with about 60 percent of the United States (U.S.) adults reporting they take at least one prescription medication in 2021 — a significant increase from 44 percent in 2000 — the healthcare supply chain plays an increasingly important role in the U.S. healthcare market.<sup>13,14</sup> The pharmaceutical industry, and the supply chain that safely and reliably delivers prescription medicines, is not only crucial for patient health, but also serves as the cornerstone of healthcare economics in the U.S.

Pharmaceutical distributors, entities that deliver medical products to healthcare providers and facilities, are instrumental stakeholders within the healthcare supply chain. They establish seamless supply chains to ensure minimal disruptions, streamline logistics to reduce distribution costs, refine inventory management techniques, implement more efficient handling protocols to mitigate drug wastage and safeguard medication integrity through stringent temperature-controlled logistics for cold-chain storage.<sup>15,16</sup>

Distributors navigate operational complexities to support the availability of vital medicines to ensure resilience and, ultimately, the seamless delivery of essential medicines to those in need. Additionally, distributors are enhancing data collection and analysis methodologies to overcome data limitations, integrating artificial intelligence (AI) to revolutionize existing processes and devise innovative solutions.

Though distributors' current use of generative AI is nascent, companies' future adoption of AI will require advances in technical expertise, data quality and infrastructure, guidelines and federal policy.<sup>17</sup> While the current use of AI among distributors is still emerging, this paper primarily highlights trends, perspectives and initiatives related to the potential future applications of AI in addressing critical business needs. It should be noted that findings on future AI trends are based on a limited sample of interviewees and survey respondents, and may not fully represent the broader industry's efforts toward active AI use. Furthermore, this paper provides an overview of the challenges faced by distributors, explores both current and future use cases of AI, and offers insights into the difficulties of implementing AI.



<sup>15</sup> Healthcare Distribution Alliance. "Drug Shortages." Last Updated February 2024. <https://hda.org/drug-shortages/>.

<sup>16</sup> Healthcare Distribution Alliance. "The Future of U.S. Pharmaceutical Cold Chain Distribution." March 2024. <https://hda.org/publications/the-future-of-u-s-pharmaceutical-cold-chain-distribution/>.

<sup>17</sup> The White House. "Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence." October 30, 2023.

## BACKGROUND

The healthcare supply chain is critical in ensuring that essential medicines and medical products are available to patients. It is a complex system that involves multiple stakeholders that contribute to producing, distributing and delivering drugs. Pharmaceutical distributors play a unique role in this system, delivering 10 million products from more than 1,200 manufacturers to 330,000 pharmacies, hospitals, providers and other healthcare facilities each day.<sup>18 19</sup> Distributors also provide management and logistics services to support an efficient and safe supply chain.

Although distributors work with multiple stakeholders to provide patients with access to their medications, national and regional distributors face operational dynamics both upstream and downstream that require innovative solutions. They must manage fluctuating demand, ensure product integrity, optimize delivery routes and comply with strict regulations. Despite complexities, opportunities for innovation abound, such as leveraging technology for real-time visibility and predictive analytics. However, obstacles like legacy systems and cybersecurity threats persist. Success depends on distributors embracing technologies, such as artificial intelligence (AI), fostering collaboration and prioritizing compliance to achieve agility and growth.

## INTRODUCTION TO AI

According to the Office of Management and Budget's guidelines on advancing governance, innovation and risk management for agency use of artificial intelligence (AI), AI is defined as "any system that can perform tasks that typically require human intelligence. These tasks could include decision-making, problem-solving, understanding language, and more." The memo focuses on "safety-impacting AI" and "rights-impacting AI," laying out specific definitions and guidelines for their use.<sup>20</sup> AI can perform tasks like pattern recognition, learning from experience, drawing conclusions and making predictions.<sup>21</sup>

Machine learning (ML), a subset of AI as defined by the Massachusetts Institute of Technology, involves algorithms that enable computers to learn from data and make decisions.<sup>10</sup> AI and ML revolutionize the healthcare supply chain by analyzing data in real-time and predicting demand accurately. Distributors play a crucial role in this transformation by optimizing inventory, streamlining procurement and enhancing supply chain resilience. They achieve this while diversifying their supplier base and maintaining flexible logistics capabilities to quickly adapt to disruptions. Furthermore, AI fosters innovation and collaboration across the industry, driving improvements and operational efficiency. Implementing AI within the supply chain will bring significant benefits in the upcoming years.<sup>22</sup>

AI, including generative AI, has the potential to support production planning, inventory management and resource allocation to drive efficiencies and optimal outcomes.<sup>8 23</sup> AI-enabled business processes can also help companies "respond, recover, and thrive" more effectively during disruptions by swiftly analyzing data, identifying disruptions and adapting strategies accordingly.<sup>24</sup>

Critics, however, raise substantial concerns about AI, particularly regarding bias, discrimination, confidentiality and cybersecurity.<sup>25</sup> As AI systems increasingly handle sensitive data, the risk of data breaches grows, potentially exposing personal and confidential information. The AI integration into critical sectors, such as finance and healthcare, intensifies these concerns, highlighting the need for stringent security measures and robust governance frameworks to protect against cyber threats.<sup>26</sup> Additionally, regulators and developers must carefully oversee AI and develop equitable and fair AI policies to prevent the perpetuation or exacerbation of existing biases and discriminatory practices.

<sup>18</sup> Healthcare Distribution Alliance. "The Facts, Figures and Trends in Healthcare (2023–2024). 94th ed." 2023. <https://hda.org/publications/94th-edition-hda-factbook-the-facts-figures-and-trends-in-healthcare/>.

<sup>19</sup> Harbor Compliance. "Wholesale Drug Distributor License." Last Updated November 30, 2021. <https://www.harborcompliance.com/drug-wholesalers-and-distributors-license#:~:text=Distributors%20deliver%2010%20million%20products, facilities%20across%20the%20United%20States.>

<sup>20</sup> Office of Management and Budget. "Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence." March 28, 2024. <https://www.whitehouse.gov/wp-content/uploads/2024/03/M-24-10-Advancing-Governance-Innovation-and-Risk-Management-for-Agency-Use-of-Artificial-Intelligence.pdf>

<sup>21</sup> United States Department of Health and Human Services. "Artificial Intelligence (AI) at HHS." Last updated June 6, 2024. [https://www.hhs.gov/about/agencies/asa/ocio/ai/index.html#:~:text=Artificial%20intelligence%20\(AI\)%20enables%20computer, conclusions%2C%20making%20predictions%2C%20etc.](https://www.hhs.gov/about/agencies/asa/ocio/ai/index.html#:~:text=Artificial%20intelligence%20(AI)%20enables%20computer, conclusions%2C%20making%20predictions%2C%20etc.)

<sup>22</sup> Kumar, Ashwani et al. "Managing healthcare supply chain through artificial intelligence (AI): A study of critical success factors." January 2023. <https://doi.org/10.1016/j.cie.2022.108815>.

<sup>23</sup> Singh, Navdeep et al. "AI and IoT: A Future Perspective on Inventory Management." November 2023. <https://doi.org/10.22214/ijraset.2023.57200>.

<sup>24</sup> Singh, Navdeep et al. "AI and IoT: A Future Perspective on Inventory Management." November 2023.

<sup>25</sup> The Healthcare and Public Health Sector Coordinating Council. "Health Industry Cybersecurity-Artificial Intelligence Machine Learning (HIC-AIM)." February 2023. <https://healthsectorcouncil.org/health-industry-cybersecurity-artificial-intelligence-machine-learning/>.

<sup>26</sup> The Healthcare and Public Health Sector Coordinating Council. "Health Industry Cybersecurity-Artificial Intelligence Machine Learning (HIC-AIM)." February 2023.

AI is currently used across many industries (for example, agriculture, e-commerce and others).<sup>27</sup> In the 1950s, researchers planted the seeds of AI with the development of early computer programs capable of logical reasoning. During this era, AI remained largely confined to academic research institutions and government projects. However, by the 2020s, AI had evolved into an integral part of many industries. In finance, companies deployed AI algorithms for algorithmic trading, portfolio management and customer service automation.<sup>28</sup> Agriculture witnessed the emergence of precision farming techniques, as AI-powered drones and sensors optimized crop yields and resource usage. The technology identifies soil deficiencies and provides planting recommendations. E-commerce platforms employed AI for targeted marketing, supply chain optimization and dynamic pricing.<sup>24</sup> A recent study by McKinsey & Company reveals that AI has varying impacts on business functions across industries, with many experiencing high impacts on marketing, sales and software engineering.<sup>29</sup>

In healthcare, AI applications are being explored in diagnosis and drug development, among other areas.<sup>30</sup> Distributors are using or are in the process of implementing AI solutions in key areas such as inventory management, forecasting, workforce productivity and order fulfillment, among others. The potential of AI to transform the healthcare supply chain is particularly relevant to optimizing drug availability and distribution costs for distributors. Integrating AI becomes crucial for distributors to stay competitive and efficiently meet growing demands as the industry evolves. AI algorithms have the potential to analyze historical data, market trends and external factors to optimize drug availability, cost of distribution and reduce waste. Incorporating AI technology into these processes for distributors has the potential to streamline operations, improve efficiency and enhance patient safety. Yet, the drive to solve business problems with AI has highlighted the need for accessible, high-quality data, which remains a challenge across the industry.

This report investigates how distributors are evaluating AI and the potential impact these technologies could have on their business operations. Findings are based on a series of interviews and surveys with senior executives at pharmaceutical distribution and AI-related companies.

## METHODOLOGY

Between December 2023 and January 2024, Avalere, a third-party vendor, was engaged to conduct a series of interviews and administer a survey to senior executives at pharmaceutical distribution and AI-related companies. The aim was to determine the most pressing issues that AI presents for the drug distribution industry.

### Interviews

Sixteen stakeholders were interviewed across five companies, including senior executives representing the data and analytics, information technology, legal and government relations functions within their companies. Organizations represented included national and regional drug distributors, and a software service provider.

Interview questions focused on the current challenges drug distributors face, the current and future role of AI in the healthcare supply chain, and opportunities to use AI for drug distribution efficiency and optimization. Interviews also explored the potential use of AI in pharmaceutical distribution to ensure safety, security, integrity and business continuity/disaster preparedness (Appendix I).

### Surveys

Surveys were also conducted through Avalere, and required respondents to pass a set of screening criteria. To participate in the survey, respondents were required to work for a national or regional drug distributor, be familiar with current uses for AI or plans for AI within their company, and have at least two years of experience in pharmaceutical distribution.

Twenty-three respondents completed the survey. Of those respondents, the majority (70 percent) worked for national distributors, and the rest worked for regional distributors (30 percent). Most respondents have worked in the pharmaceutical field for at least nine years and were either familiar or very familiar with how AI is being used at their company.

<sup>27</sup> Forbes Media LLC. "Applications of Artificial Intelligence Across Various Industries." January 2023. <https://www.forbes.com/sites/qai/2023/01/06/applications-of-artificial-intelligence/?sh=1c6c1c623be4>.

<sup>28</sup> Tableau. "What is the history of artificial intelligence (AI)?" May 2024. <https://www.tableau.com/data-insights/ai/history#:~:text=Birth%20of%20AI%3A%201950%2D1956&text=The%20term%20E2%80%9Cartificial%20intelligence%E2%80%9D%20was,intelligence%20called%20The%20limitation%20Game>.

<sup>29</sup> McKinsey & Company. "The economic potential of generative AI: The next productivity frontier." June 2023. <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-AI-the-next-productivity-frontier#introduction>.

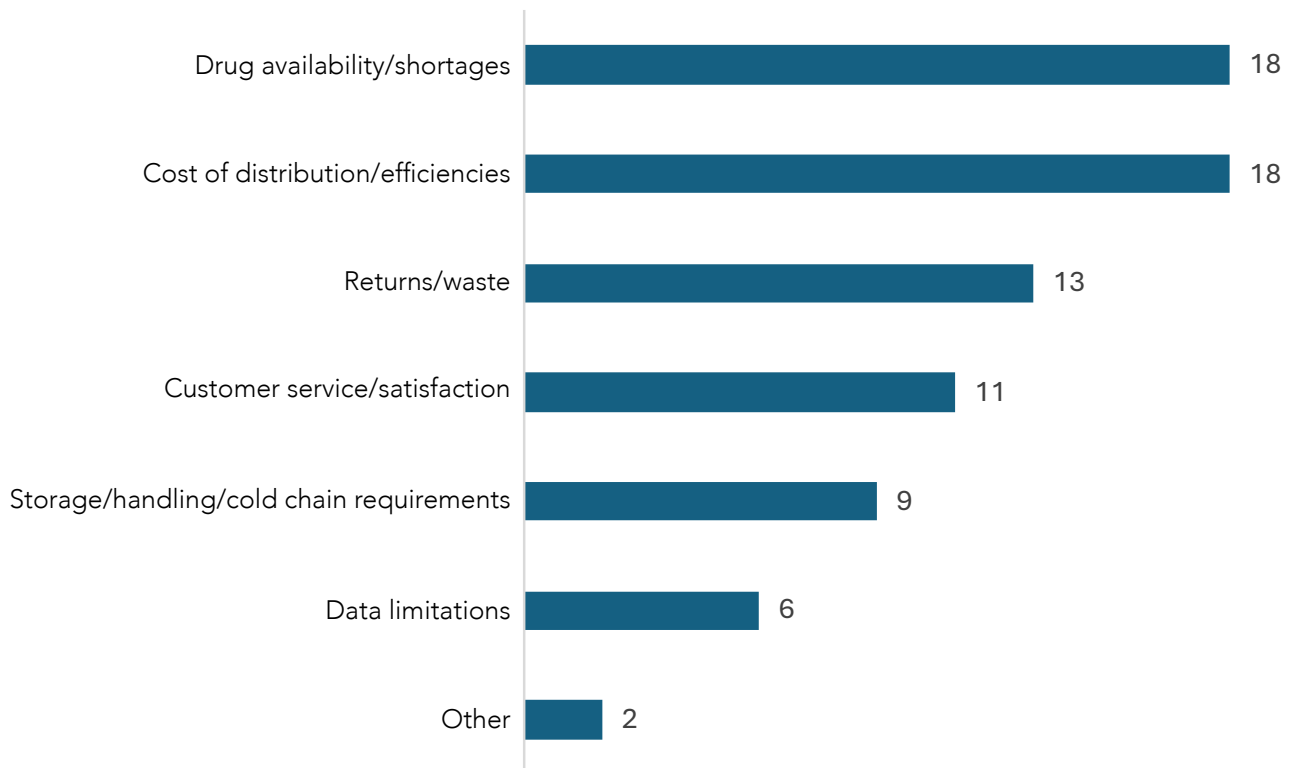
<sup>30</sup> Los Angeles Pacific University. "Revolutionizing Healthcare: How is AI being Used in the Healthcare Industry." December 2023. <https://www.lapu.edu/ai-health-care-industry/>.

Survey questions focused on exploring key business challenges that drug distributors may face, current activity related to AI, how effective AI will address key challenges, the most promising role for AI in drug distribution and AI risks and governance principles (Appendix II).

## OPERATIONAL CHALLENGES IN THE HEALTHCARE SUPPLY CHAIN

Within the complex landscape of pharmaceutical distribution, various challenges persist across the supply chain. Interviewed and surveyed national and regional distributors grapple with myriad issues encompassing concerns such as drug availability and shortages; optimization of distribution costs (time, money and labor) to improve efficiency; management of returns and waste; ensuring high levels of customer service satisfaction; adhering to stringent storage, handling and cold chain requirements; and contending with data limitations (Figure 1).

Figure 1: What are the pain points/business challenges for your business unit? (n=23 individuals)



### Drug Availability and Shortages

Distributors consistently emphasize drug availability and shortages as a primary pain point in the supply chain, with 78 percent of respondents acknowledging it as a significant challenge. These issues have far-reaching implications, affecting patient care and operational efficiency throughout the distribution process. Despite the challenges distributors face, AI holds significant potential as a predictive tool. Currently, 55 percent of respondents view AI as being effective or very effective in addressing these shortages. AI offers the most support to distributors in two areas in particular: as a predictor of drug shortages and as a tool to allocate drugs to effectively manage supply and demand. The challenge however, according to those interviewed, is that some suppliers are unwilling to share data because of competition concerns, making it difficult for distributors to train machine learning algorithms to predict supply shortages accurately. With better access to data such as downstream customer sales, distributors noted optimism about using AI to manage demand-driven shortages effectively. With improved data availability, AI could serve as a crucial tool for predicting and mitigating drug shortages.

### Cost of Distribution

The costs linked with distribution represent another critical supply chain concern, with 78 percent of respondents recognizing it as a significant challenge. These costs encompass transportation, warehousing, packaging and handling, putting pressure on distributors to optimize them while maintaining service levels and competitiveness. In contrast to the perception of AI's effectiveness in addressing drug shortages (55 percent), 89 percent of respondents expect that an AI solution will be effective or very effective at reducing the cost of distribution.



## Returns and Waste

Within the supply chain, there is the potential for waste generation. Returns and waste pose significant challenges for distributors, with 56 percent of respondents acknowledging them as pain points. This encompasses the complexities of handling returned products, managing expired or damaged inventory, and minimizing waste throughout the distribution process. Seventy-six percent of the stakeholders indicate that returns/waste is a challenge and that implementing an AI solution will be effective or very effective at addressing the issue.

## Customer Service

As pharmaceutical distributors interact with many stakeholders within the supply chain, customer service is inherently a focus of the business. Just over half of survey respondents perceive customer service as challenging for their business unit (for example, through the cost of human resources). This underscores the complexities inherent in providing high-quality service across diverse customer segments with varying needs and expectations. However, only 36 percent of survey respondents report that AI will be effective or very effective at addressing this issue.

## Storage and Handling

Storage and handling are notable pain points within pharmaceutical distribution, with 39 percent of respondents highlighting it as a significant challenge. Storing and handling pharmaceutical products requires attention to detail, adherence to regulations and investment in specialized equipment. Challenges may include maintaining temperature-controlled environments for sensitive medications and ensuring proper handling to prevent damage or contamination. Among those who identify storage and handling as pain points, survey respondents were optimistic about the utility of AI; seventy-eight percent expressed confidence in the efficacy of AI solutions to address these issues.

## Data Limitations

Finally, in addition to the gaps in the upstream visibility, 26 percent of respondents reported internal data limitations as a significant challenge. The prevalence of data limitations suggests that many pharmaceutical distributors grapple with issues such as data silos, outdated technology infrastructure and inadequate scalability.

Expectations regarding the efficacy of AI solutions in overcoming data limitations are divided among respondents. Fifty percent of respondents expect AI to be very effective, 33 percent expect it to be somewhat effective and 17 percent expect it to be ineffective. Positive sentiment could be attributed to indirect mechanisms such as revitalized efforts to establish the standard, high-quality data pipelines required for AI infrastructure and direct mechanisms by which AI is being proposed to help improve data quality through extracting structured data from unstructured data, images, voice and other mediums.

As pharmaceutical distributors navigate the complexities of addressing the largest challenges in the supply chain, finding the right balance between AI-driven solutions and traditional approaches will be essential in maximizing the value of data assets and driving operational excellence.

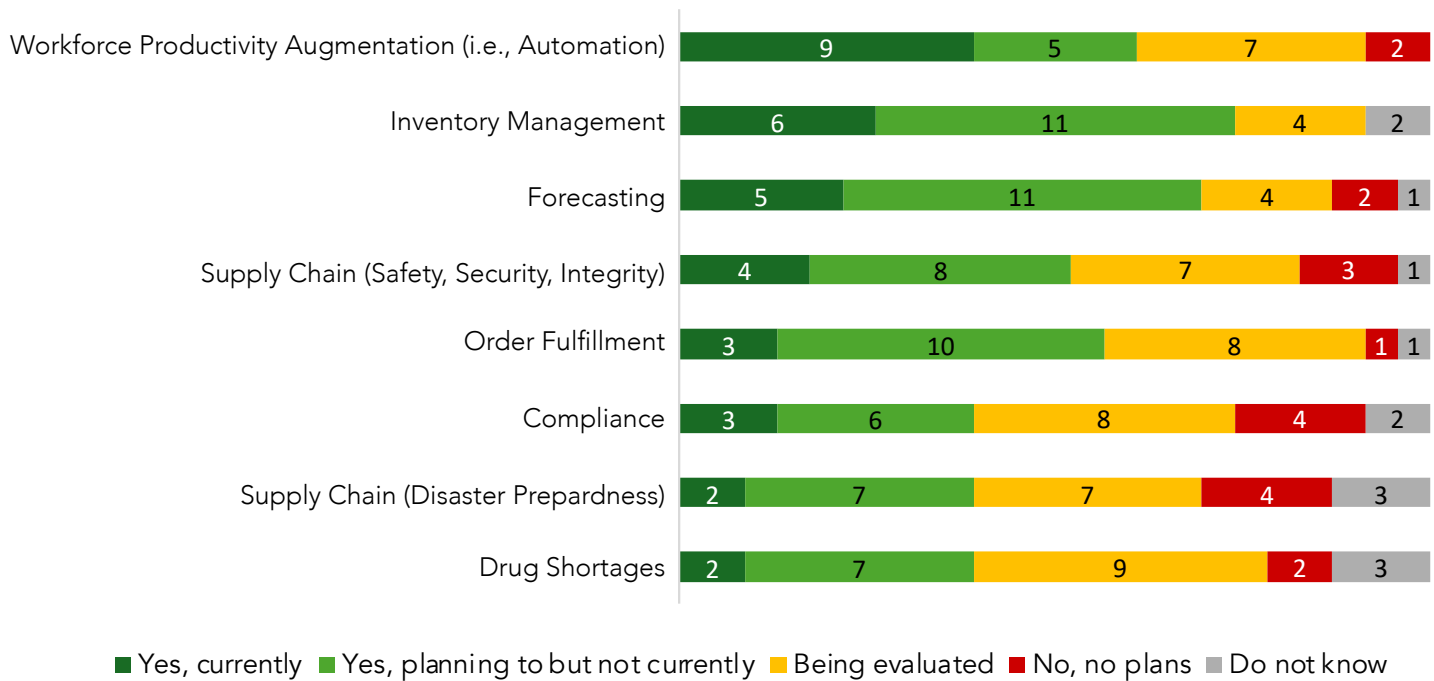
## CURRENT AND POTENTIAL USE CASES FOR AI AS A SOLUTION

### Current Use Cases for AI

AI is presently employed across diverse applications within the healthcare supply chain, though to varying extents (Figure 2). The most prevalent application of AI reported is for enhancing workforce productivity, with 39 percent of respondents indicating they use AI for this application. Following closely, 26 percent of respondents use AI to optimize inventory management, while 21 percent use its capabilities for forecasting. Seventeen percent of respondents reported using AI to bolster supply chain safety, security and integrity.

However, the adoption of AI for other critical tasks is low. Thirteen percent report the current use of AI for order fulfillment and compliance management and 8 percent report use for disaster preparedness within the supply chain and addressing drug shortages. This observation follows the cautiously optimistic approach of distributors choosing low-risk applications at this stage ahead of tackling other applications. Further, there is considerable potential for further integration of AI technologies across a broader spectrum of supply chain functions to enhance efficiency and resilience.

Figure 2: What use case(s) is your company/business unit currently using or planning to use AI? (n=23 individuals)



Distributors are also exploring applications for AI in areas beyond those reported in survey results. For example, one distributor announced that they are working on an AI and machine-learning tool to inform hospital purchasing decisions amid rising medication expenses due to the growth of specialty therapies and biosimilars. The tool combines diagnostic and clinical data with real-time customer purchasing and utilization data for pharmaceutical products. It is expected to inform purchasing decisions and insights related to reimbursement and inventory needs.<sup>31</sup>

## Potential Use Cases for AI

Survey findings show that about half of the respondent companies intend to incorporate AI into critical areas such as forecasting, inventory management and compliance, indicating significant untapped potential for AI adoption. One distributor company offered that AI predictive modeling could be particularly available for new drug/therapy launches. As more products enter the market in a therapeutic category, AI could help model a balance of product availability and customer demand to ensure an adequate but not a surplus of inventory remains available.

Moreover, about a third of surveyed companies are actively assessing the viability of AI applications in workforce productivity enhancement and addressing drug shortages. Interviewees echo these sentiments, identifying similar areas for AI integration, including forecasting, inventory management, order fulfillment and workforce productivity augmentation.

Several national distributors are either developing or planning to implement package tracing solutions to enhance “last/ final mile” delivery (i.e., to the recipient). Warehouse automation initiatives are also underway, with multiple national distributors dedicating resources to this endeavor. A national distributor noted, “When considering AI in distribution, we are prioritizing therapeutic area focus, final mile delivery tracking, and warehouse automation for safety, security, and integrity.” Plans are also in motion to employ AI in preemptively identifying storage risks, particularly in maintaining the integrity of the cold chain.<sup>32</sup> Applications that may use AI, like cold-chain, may use an Internet of Things (IoT), a set of technologies that allows products or machines to connect with one another and communicate about their attributes.<sup>33</sup> When asked, an interviewee noted, “We are considering an AI solution for cold chain distribution, leveraging IoT on ultra-cold freezers for preventive maintenance to reduce spoilage, and are looking for more comprehensive upstream and downstream supply chain data for enhanced efficacy.”

<sup>31</sup> Cardinal Health, Inc. “Fiscal 2023 Environmental, Social and Governance Report.” February 2024. <https://www.cardinalhealth.com/content/dam/corp/web/documents/Report/cardinal-health-fy23-ESG-report.pdf>.

<sup>32</sup> Healthcare Distribution Alliance. “The Future of U.S. Pharmaceutical Cold Chain Distribution.” March 2024. <https://www.hda.org/publications/the-future-of-u-s-pharmaceutical-cold-chain-distribution/>.

<sup>33</sup> Shah, Rushabh et al. “IoT and AI in Healthcare: A Systematic Literature Review.” 2018. [https://doi.org/10.48009/3\\_iis\\_2018\\_33-41](https://doi.org/10.48009/3_iis_2018_33-41).

Although distributors reported focusing on forecasting, inventory management and order fulfillment as top potential use cases for AI, interviewees also highlighted other potential use cases. For example, one regional distributor noted an opportunity to use data analytics to manage situations where a customer engages multiple distributors instead of committing to just one, a phenomenon referred to as “leakage.” This scenario can lead to short-term business loss and might risk long-term customer relationships. Effectively identifying, predicting and deciphering the factors contributing to leakage early could offer distributors a significant competitive edge. One interviewee noted “there is a real opportunity for AI solutions in managing leakage — currently, it’s challenging to assess customer engagement levels based solely on leakage; much of this is intuition-based. AI can help us identify patterns.” AI-based recognition of conditions leading up to leakage could lead to early identification, proactive response and better customer retention.

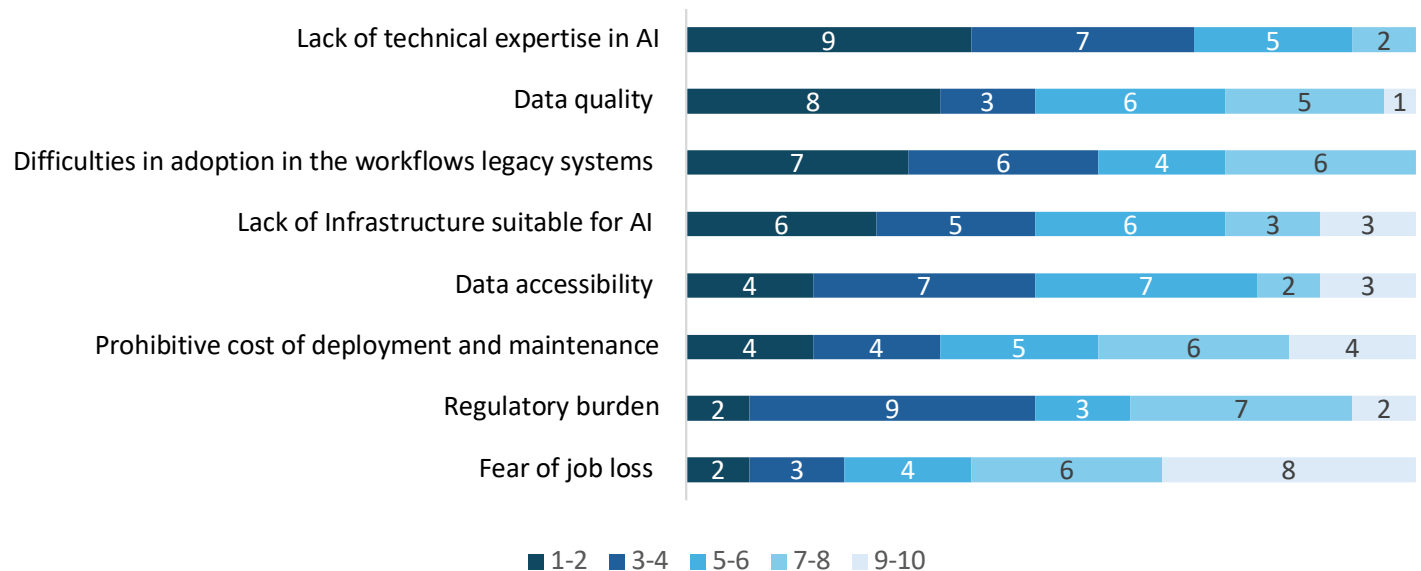
Finally, the interviewed distributors stated they are exploring the potential of AI-driven supply chain risk modeling, focusing on weather-based modeling to mitigate inventory disruptions effectively.

These insights underscore the opportunities AI presents for revolutionizing supply chain operations and bolstering resilience across the pharmaceutical distribution landscape.

## CHALLENGES IN IMPLEMENTING AI

AI algorithms have the potential to increase efficiency for many processes, but the technology creates several challenges for distributors that aim to implement AI. According to survey results and interviewees, the top challenges reported by distributors include a lack of technical expertise, data quality and difficulties in adopting the workflows of legacy systems (Figure 3). Asking the survey question was important because it helped identify specific obstacles that hinder AI implementation. By understanding these challenges, distributors can develop targeted strategies to address them and improve their AI adoption process. As a new and growing field, distributors must continue to source new talent to build their AI capabilities. AI implementation requires specialized knowledge in areas like ML and AI system design. To meet the demand for AI expertise, distributors need to invest in recruiting new talent and enhancing the skills of their current employees through upskilling and reskilling programs. To supplement the sourcing of new talent, one distributor noted they are using internal upskilling and reskilling programs to continue to expand their capabilities amid high demand for talent.

Figure 3: What are the main challenges your company/business unit faces in using AI? Ranked in order of importance with 1 as the “most important” and 10 as “least important” (n=23 individuals) (shown as number of respondents by rank)



AI technology requires consistent, high-quality, granular data to be available while training ML algorithms and during real-life deployment. Both interviewees and survey respondents reported data quality and accessibility as potential barriers to creating accurate AI algorithms. For example, interviewed distributors cited incomplete data, data in inconsistent formats or data that were simply unavailable as key reasons for being unable to deploy AI to solve operational challenges. Modern AI applications often exceed the capabilities of legacy systems, requiring costly upgrades or the development of workaround solutions. Distributors are striving to mitigate this issue and improve data quality by tracking existing

processes like last/final mile delivery via IoTs and digital twins. To ensure the optimization of AI algorithms, distributors will likely be required to invest in resources specific to data quality assurance, including possible industry adoption of standard protocols.

Survey respondents rated concerns such as prohibitive deployment and maintenance costs and the fear of job loss as less important. Both survey respondents and interviewees emphasized how AI has the potential to optimize business operations and how the combination of human capital and AI could transform existing processes.

## LOOKING FORWARD

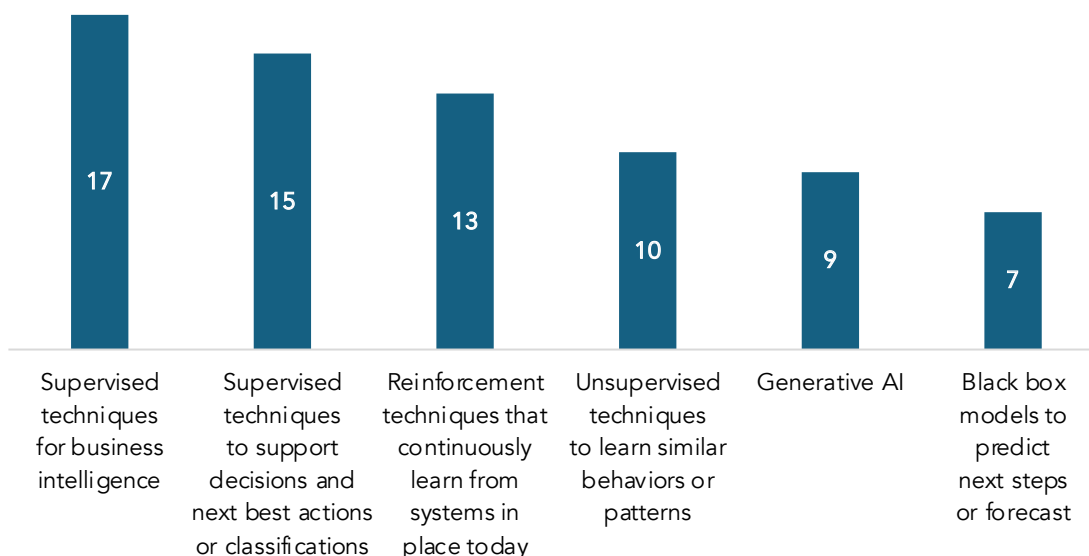
### AI/Machine Learning Algorithms With the Greatest Utility

Stakeholders implementing AI should apply different capabilities to address specific needs at each point in the supply chain, according to survey results. These capabilities include supervised or ML algorithms, unsupervised techniques, reinforcement techniques, deep learning and generative AI. Typical use cases for supervised ML algorithms are forecasting and predictive algorithms used to determine the quantities of products to be held at various warehouses. Survey findings suggest that unsupervised ML algorithms may be used to find similarities in consumers and group them into similar subsets of common behaviors. Reinforcement techniques are used to learn from ongoing feedback from the consumer and improve the algorithm for the best customer satisfaction. Deep learning (sometimes known as the black box) models predict/forecast demand or determine the next best steps to take in a complex situation. Recently, advances in generative AI have opened a new door to produce insights from unstructured data from client interactions in image, voice and text forms. Generative AI's ability to provide accurate, easy-to-use chatbot interfaces has many applications in building a more customer-centric supply chain network.<sup>34</sup>

Survey respondents expected supervised machine learning methods to have the greatest impact on future supply chain business intelligence (Figure 4), providing much-needed insights on the next best actions to improve customer retention, which was highlighted in interviews as a use case. Survey results indicate that supervised machine learning was closely followed by reinforcement learning and unsupervised algorithms, highlighting an increased focus on the need for distributors to understand customer behavior.

Generative AI and black box models were noted as having the least impact on the future of pharmaceutical distribution. When probed during an interview, one of the interviewees responded, "We do have customer service teams that use an internal virtual assistant to help navigate conversations [with customers], but it's not exposed yet externally, though that is one of the line items on our roadmap." The overall lower ranking of generative AI in the survey response could be partially explained by its relative immaturity compared to supervised and unsupervised machine learning, the pace of evolution, and regulatory uncertainty leading to a cautious outlook toward generative AI's future impact.

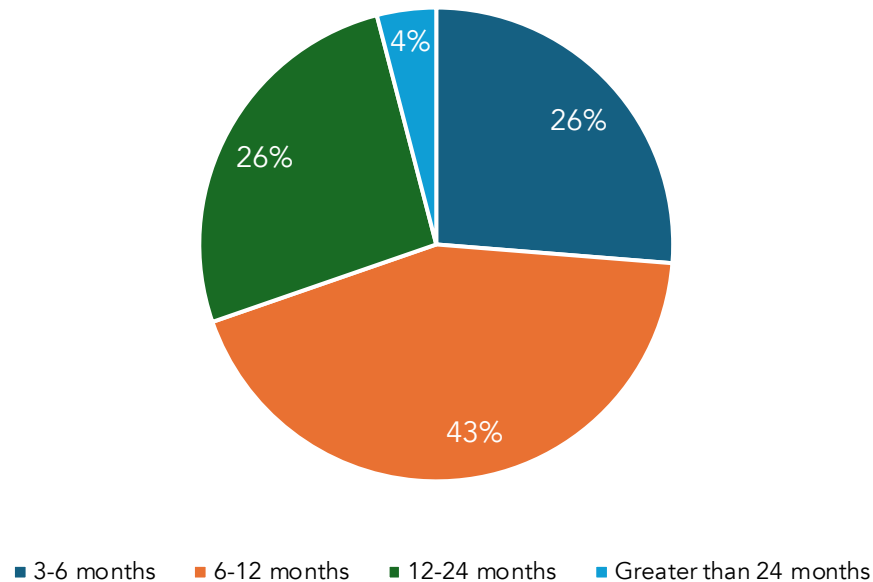
Figure 4: What AI capabilities do you foresee having the greatest impact on drug distribution in the future? Displayed as the number of respondents that selected each capability (n=23 individuals)



<sup>34</sup> Marr, Bernard. "How Generative AI Is Revolutionizing Customer Service." Forbes. January 24, 2024. <https://www.forbes.com/sites/bernardmarr/2024/01/26/how-generative-ai-is-revolutionizing-customer-service/?sh=dbf50336944c>.

Distributors reported similar time to production for new AI developments, ranging from three months to over two years. More than 69 percent of respondents reported that, on average, AI-based products move from concept to deployment within a year (Figure 5).

Figure 5: On average, how long does it take for AI-based products to move from a concept to deployment in production? (n=23)



## Future of AI Governance and Guidelines

As distributors leverage AI algorithms to tackle larger challenges, adopting robust AI governance frameworks will be important. Survey respondents highlighted that existing governance entities are tasked with responsibilities ranging from AI ethics and project approval to bias evaluations and budget oversight. Approximately half of the respondents, primarily national distributors, are already employing responsible AI frameworks like the U.S. Government Accountability Office’s (GAO) AI framework, Google’s Responsible AI Practices, Microsoft’s Responsible AI Standard and the National Institute of Standards and Technology (NIST) Risk Management Framework to guide their efforts.<sup>35 36 37 38</sup>

The U.S. GAO’s AI Framework provides guidelines on accountability, transparency and ethics in AI deployment, ensuring AI systems are trustworthy and compliant with regulations. Google’s Responsible AI Practices focus on fairness, transparency, privacy and security to mitigate AI risks. Microsoft’s Responsible AI Standard emphasizes inclusiveness, reliability, safety and accountability in AI development and deployment. The (NIST) Risk Management Framework helps identify, assess and manage AI risks, promoting secure and reliable AI systems. By using these frameworks, distributors can effectively navigate AI implementation, ensuring ethical, transparent and effective use of AI technologies.

More recently, there has been a movement at the federal level to establish policies and frameworks for AI development and use in healthcare. In October 2023, President Biden signed an executive order that requires the Secretary of the Department of Health and Human Services (HHS) to establish an HHS AI Task Force. The goal of this task force is to develop a strategic plan that includes policies and frameworks on “responsible deployment and use of AI and AI-enabled technologies in the health and human services sector.”<sup>39</sup> Areas outlined for policies and frameworks focused on research and discovery, drug and device safety, healthcare delivery and financing, and public health. In the future, HHS is expected to release more materials and become more involved in the AI regulatory landscape.

<sup>35</sup> U.S. Government Accountability Office. Artificial Intelligence: An Accountability Framework for Federal Agencies and Other Entities. GAO-21-519SP. June 30, 2021. <https://www.gao.gov/products/gao-21-519sp>.

<sup>36</sup> “Responsible AI practices.” Google. February 2024. <https://ai.google/responsibility/responsible-ai-practices/>.

<sup>37</sup> “Microsoft Responsible AI Standard, v2.” Microsoft. June 2022. <https://blogs.microsoft.com/wp-content/uploads/prod/sites/5/2022/06/Microsoft-Responsible-AI-Standard-v2-General-Requirements-3.pdf>.

<sup>38</sup> National Institute of Standards and Technology. “Artificial Intelligence Risk Management Framework (AI RMF 1.0).” January 2023. <https://doi.org/10.6028/NIST.AI.100-1>.

<sup>39</sup> The White House. “Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence.” October 30, 2023.

Sixty-five percent of survey respondents noted that federal policy changes would be needed to enable the use of AI in pharmaceutical distribution. Distributors expressed the need to protect quality standards, match the level of regulation that the pharmaceutical industry follows in other areas and provide oversight as top reasons for policy changes. As distributors continue to develop AI algorithms, recommend industry governance, as well as technology frameworks and guidelines, they will become increasingly essential to ensure quality standards are maintained.

Adding to this dynamic regulatory environment, a report authored by the Bipartisan Senate AI Working Group, “Driving U.S. Innovation in Artificial Intelligence: A Roadmap for Artificial Intelligence Policy in the United States Senate,” introduces further considerations for the AI policy landscape.<sup>40</sup> This roadmap underscores the importance of fostering innovation while ensuring ethical standards, particularly emphasizing sectors like healthcare where AI has profound implications. It advocates for tailored policy measures that reflect the unique needs of industries, including pharmaceutical distribution, ensuring that AI development aligns with national interests and public safety standards.



The Bipartisan Senate AI Working Group. “Driving U.S. Innovation in Artificial Intelligence: A Roadmap for Artificial Intelligence Policy in the United States Senate.” May 2024. [https://www.schumer.senate.gov/imo/media/doc/Roadmap\\_Electronic1.32pm.pdf](https://www.schumer.senate.gov/imo/media/doc/Roadmap_Electronic1.32pm.pdf).

## CONCLUSION

Pharmaceutical distributors will inevitably adopt AI to optimize their future business practices. This adoption crucially depends on many factors, including human capital and the availability of end-to-end, granular, high-quality data representing upstream manufacturing, distribution and downstream use. Adoption also depends on standardized processes, governance and regulatory oversight. Like other industry supply chains, the use of AI will be an integral component of future business optimization.

Currently, AI is experiencing growing pains, with its deployments primarily in targeted applications to address certain challenges. However, the industry is poised to use and experiment with AI. Distributors, based on interviews and surveys, express a strong optimism about AI's future. They are actively hiring AI experts, setting up dedicated AI business units and departments, and increasingly tackling larger, more complex problems with AI solutions. As their expertise grows and their data pipelines mature, the use of AI in the pharmaceutical distribution sector is expected to accelerate its integration of AI. This growth will occur regardless of any additional regulatory actions needed to clarify uncertainties. The industry is set for a rapid and transformative expansion of AI use, driving significant advancements independently.

## LIMITATIONS

While this paper includes insights into the current use of AI among distributors, its primary purpose is to highlight thoughts, trends and initiatives related to the potential and future use of AI to solve eminent business needs. Moreover, findings on potential and future use of AI trends were based on a limited set of interviewees and survey respondents (n=16 and n=23, respectively). As such, the findings may not be fully representative of the industry's initiatives related to active AI use.

## **APPENDIX I: INTERVIEW QUESTIONS**

### **Role of AI in Biopharma**

1. What do you think about AI in the context of the biopharma supply chain?
2. What are the most critical pain points for the current biopharma supply chain? Do you see potential for AI to help solve any of these pain points?

### **Potential Use of AI in Pharmaceutical Distribution**

1. What are your thoughts on the potential role of AI in inventory management (e.g., demand forecasting, consumer purchasing behavior, etc.)?
2. Do you see the decision-making capabilities of AI as a potential benefit in the Biopharma supply chain? If yes, can you please elaborate?
3. Has your approach to working with healthcare providers changed with the advent of AI, virtual assistants and any other manifestations of AI to help the connected-customer experience?

### **Potential Use of AI in Drug Distribution Safety, Security and Integrity**

1. What are your thoughts on the potential role of AI in the supply chain in the below buckets?
  - a. Pharma 4.0
  - b. Fraud/abuse prevention

### **Challenges and Opportunities To Use AI for Drug Distribution Efficiency and Optimization**

1. What do you think about the future of AI in the biopharma supply chain?
2. What are your current short- and long-term initiatives, interests or organizational activities related to AI functionality?
3. In your opinion, what is the single change that would most improve the biopharma supply chain? Could that be helped or hindered by AI?
4. Are there additional skills your organization needs in order to fully leverage the opportunities presented by AI?
5. Do you have final thoughts to share about your outlook on the role of AI in the biopharma distribution chain in the next 5 years?



## APPENDIX II: SURVEY QUESTIONS

### Business unit/company profile:

Q1. What is your title? \_\_\_\_\_

Q2. What business unit(s)/function(s) do you support in your company?

- a. Demand planning
- b. Drug sourcing
- c. Inventory management
- d. Pricing
- e. Customer Sales
- f. Distribution and logistics
- g. Analytics
- h. Finance
- i. Senior Executive
- j. Other, please enter: \_\_\_\_\_

Q3. How is your business unit structured and organized?

- a. Shared service across different business units (e.g., Advanced Analytics/AI/Center of Excellence)
- b. Stand-alone business segment (e.g., Specialty Distribution)
- c. Customer segment (e.g., Hospital, Retail Pharmacy)
- d. Other \_\_\_\_\_

### An overview of business challenges that drug distributors may face:

Q4. What are the pain points/business challenges for your business unit?

- a. Cost of distribution/efficiencies
- b. Drug availability/shortages
- c. Storage/handling/cold chain requirements
- d. Returns/Waste
- e. Database limitations
- f. Customer service/satisfaction
- g. Other \_\_\_\_\_

### Current activity and emerging AI trends in the drug supply chain:

Q5. Do you believe that AI can help solve any of your company or business unit's challenges?

- a. Yes
- b. No
- c. Unsure

Q6. What do you see as the primary objectives for AI initiatives in improving drug distribution? Please rank up to 3.  
[select up to 3 and indicate rank order]

- a. Connected customer experience
- b. Cost optimization
- c. Quality control
- d. Revenue growth
- e. Business continuity
- f. Other \_\_\_\_\_

**How effective AI will be at addressing key business challenges:**

Q7. You selected the following pain points in your business. How effective do you expect AI will be at addressing these issues?

Q8. What are the main challenges your company/business unit faces in using AI? Please rank in order of importance (with 1 as the "most important" and 10 as "least important"). To rank: Select, hold and drag to rank/re-rank your choices.

Rank the 10 items below. 1 = most important; 10 = least important.

	1	2	3	4	5	6	7	8	9	10
Data accessibility										
Data quality										
Difficulties in adoption in the workflows legacy systems										
Fear of job loss										
Lack of infrastructure suitable for AI										
Lack of technical expertise in AI										
Prohibitive cost of deployment and maintenance										
Regulatory burden										
Other										

**Findings about the most promising role for AI in drug distribution:**

Q9. For which use case(s) is your company/business unit currently using or planning to use AI? Please select all that apply.

	Yes, currently	Yes, planning to but not currently	Being evaluated	No, no plans	Do not know
a. Forecasting					
b. Inventory Management					
c. Order fulfillment					
d. Supply Chain (Safety, Security, Integrity)					
e. Supply Chain (Disaster Preparedness)					
f. Workforce Productivity Augmentation (i.e., Automation)					
g. Drug Shortages					
h. Compliance					
i. Other					
j. None					

Q10. Does your company use AI for any of these specific use cases?

	YES	NO
Strategic stockpiling/drug shortages mitigation		
Demand planning, inventory planning and scheduling		
Cold chain integrity protection (e.g., monitoring shipping conditions, assessing thermal capacity, etc.)		
AI augmented with Internet of Things (IoT), (i.e., providing constant end-to-end [E2E] monitoring)		
Disaster preparedness (i.e., mitigating hurricanes, earthquakes and other natural disasters)		
Other (open text)		

Q11. The COVID-19 pandemic resulted in long-term disruption to the drug supply chain. Did your company's use of AI shift in response to pandemic-related disruptions?

a. Yes

If yes, how: \_\_\_\_\_

b. No

If no, why not? \_\_\_\_\_

Q12. What benefits is your company expecting from implementing AI for each use case?

	Connected Customer Experience	Cost Optimization	Revenue Growth	Business Continuity	Other
[IF Q11=a]					
[IF Q11=b]					
[IF Q11=c]					
[IF Q11=d]					
[IF Q11=e]					
[IF Q11=f]					
[IF Q11=g]					

Q13. On average, how long does it take (in months) for AI-based products to move from a concept to deployment in prouction?

	1-3 months	3-6 months	6-12 months	12-24 months	24 months
On Average					

**Q14. Which AI capabilities do you foresee having the greatest impact on drug distribution in the future?**

- a. Unsupervised techniques to learn similar behaviors or patterns (e.g., clustering techniques)
- b. Supervised techniques for business intelligence like price prediction (e.g., regression methods)
- c. Supervised techniques to support decisions and next best actions or classifications (e.g., decision trees)
- d. Reinforcement techniques that continuously learn from systems in place today (e.g., reinforcement learning)
- e. Black box models to predict next steps or forecast (e.g., neural networks)
- f. Generative AI
- g. Other: \_\_\_\_\_

**Assessment of AI risks and governance principles, (e.g., Responsible AI, information security, mitigating bias in data sources, health equity considerations for pharmaceutical distribution, etc.):**

**Q15. Does your company have an AI governance entity?**

a. Yes.

If yes, what responsibilities does it hold? [Select "Yes" or "No" for each]

	YES	NO
AI solution budget approval		
AI project implementation approval (project staffing, etc.)		
AI solution implementation change control, (i.e., solution design modifications and contract change orders, etc.)		
Data/information security		
Mitigating bias in data sources/AI algorithms		
Health equity considerations for drug distribution		
Responsible AI ethics		

b. No

c. Unknown

d. N/A

**Q16. Does your company use any of the following Responsible AI frameworks?**

	YES	NO	DON'T KNOW
National Institute of Standards and Technology (NIST) AI Risk Management Framework (AI RMF 1.0)			
Microsoft Responsible AI Standard v2			
Google's Responsible AI Practices			
US Government Accountability Office: Artificial Intelligence: An Accountability Framework for Federal Agencies and Other Entities			
Defense Innovation Unit: Responsible AI Guidelines in Practice			
N/A - we rely on the contractor's responsible AI framework			
Other			

Q17. How often do you source external consultants to implement AI solutions (vs. build AI solutions in-house)?

Never	Sometimes	Half the time	Often	Always

Q18. How would you describe your team's level of trust in AI?

Highly Trusted	Moderately Trusted	Neutral	Skeptical	Highly Skeptical

Q19. Which technology vendor's solutions do you use or are you planning to use to develop AI solutions?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. N/A

Q20. Do you think policy changes would be needed at the federal level to enable use of AI in pharmaceutical distribution?

- a. Yes. If yes, how? \_\_\_\_\_
- b. No. If no, why not? \_\_\_\_\_

Q21. Do you have any final thoughts you would like to share about your outlook on the potential impact AI will have on drug distribution in the coming years?

- c. Yes. If yes, please share: \_\_\_\_\_
- d. No



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