



A 5-Point Plan for Reinventing the Pharma Supply Chain

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Abstract

Digital technologies have transformed the pharmaceutical industry's transport system significantly by incorporating a digital supply chain. This paper explores the evolving landscape of the digital pharma supply chain and how it can positively influence the industry. The pharmaceutical supply chain globally faces a number of risks and challenges at both the operational and the disruptive levels. A digitalized supply chain will help them manage these risks, reduce their operational costs, and enhance their assets. It will equip them to respond positively to the customer's demand and reap profits. The paper explores the digital enablers that help to integrate digitalization in the pharma supply chains. Furthermore, the paper highlights a thorough analysis of the developments in terms of their future impact on the industry and supports factual market insights, academic literature, and industry reports. The digital transformation is beyond the technology upgrade; it is a strategic imperative to develop an enterprise's resilience, efficiency, and patient-centric service delivery in an unstable and demand-sensitive global environment.

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Introduction

Pharmaceutical companies are focusing on efficient supply chain management as they face extreme competition. These companies face challenges like reduced product life cycles, varying customer demands, and increasing costs of shipment and manufacturing (Sarimveis H, Patrinos P *et al*, 2022). This has led pharma companies to realize the critical role of supply chain management in attaining organizational goals. SCM helps them to speed up their innovations and product launches to meet the demands of the dynamic market. It also improves customer value, optimizes resource utilization, and reduces the cost of production, inventory, and transportation (Lai KHM, Ngai EWT *et al*, 2022). Pharmaceutical companies are now focusing on the development of the entire supply chain and on achieving sustainable supply performance through effective supply chain management (Khanfar A. *et al*, 2021). The implementation of digital technologies in the pharma supply chain makes smart manufacturing a reality. Digital technologies such as ICT, cyber-physical systems, IoT, blockchain, cloud computing, etc., drive smart manufacturing (Taboada I, Shee H, *et al*, 2021).

Suppliers, manufacturers, retailers, and wholesalers are all connected through data and information interactions. This sharing and collaboration enable agile responses to changes and to make strategic decisions (Wan, P.K., Huang *et al*, 2020). The application of digital technologies will penetrate deeper into the pharmaceutical supply chain and will precisely track the flow of information efficiently and securely (Salamai, A.A., 2022). Digital transformation will add impetus to innovation in the pharma chains in terms of business models, organizational structures, product processes, and sustainable supply performance (Vishwakarma *et al*, 2014). The purpose of the paper is to address the significant challenges faced by pharmaceutical companies and to address these challenges through digital transformation means. The paper also provides insights into the strategies to achieve agility in pharma supply chains through digital transformation techniques.

Major challenges for pharmaceutical supply chains:

The pharmaceutical supply chain encompasses a network of internal and external stakeholders. It also signifies the connection between them, through which the production, supply, delivery, and sales of pharma products are distributed to the end-users at the right time (Sabouhi *et al*, 2018). The pharmaceutical supply chain encompasses efficient management of the financial, material, and information flow

within the network to maximize customer satisfaction and profits (Alzaman *et al*, 2018). The same supply chain will distribute over-the-counter drugs, prescription drugs, generics, etc. Thus, there will be challenges with handling needs and operational objectives (Kapoor, 2018). For the pharmaceutical supply chain, there are two significant risks: the operational risk and the disruption risks.



Fig 1: Challenges for the pharmaceutical supply chain

a) Operational Challenges

The operational risks have short-term adverse effects and might affect the performance of the company (Osorio & Espana, 2020). Uncertainties such as customer demand, supply, cost uncertainties, etc., qualify as operational risks. It might include risks associated with people, processes, external events, and machines. Pharmaceutical companies lose millions owing to spoilage of medicine from temperature fluctuations (*et al*, 2020).

b) Disruption Challenges

These risks have a low likelihood and might cause drastic economic and social changes. Natural disasters, human threats, and technological threats drive disruption risks (Eltawy & Galleary, 2017). Lack of robust quality control and flexible production is the bottleneck of reliable drug supplies, which might result in drug shortages (Ding 2018). Quality issues are attributed to 37% of drug shortages, and demand uncertainty is attributed to 5% of drug shortages (US Federal Drug Administration, 2018). Other significant factors for drug shortages include scarcity of raw materials, manufacturing issues, lack of capacity, uncertainty of demand, etc.

Addressing pharmaceutical supply chain challenges through digital transformation:

Digitalization in supply chains refers to the strategic initiatives and end-to-end processes applied to reap operational excellence (Lehmann, 2018). Digitalization forces organizations to reinvent their business process and also encourages them to find a new way of performing business (Bouman *et al*, 2018). It reshapes the supply chain model to automate the operational tasks and fulfill the inefficiencies (Alice *et al*, 2020). The digital enablers that are implemented to achieve lean and agile supply chains are as follows.

a) IoT:

IoT refers to the series of smart devices that are connected through sensors and the internet to exchange data in real-time (Radoglou *et al*, 2019). The IoT applications, such as monitoring cold chains, tracking man and machine resources, warehouse management, and packaging, are well suited for pharmaceutical supply chains. It can help manage supply chains, manufacture products, and improve services (Sharma *et al*, 2020).

Drugs and vaccines are generally susceptible to temperature variations and might lose their potency if the temperature is not maintained (Hasant *et al*, 2020). IoT solutions can help pharmaceutical companies monitor cold chain environments in real time by embedding sensors in the tracking equipment (Hasanat *et al*, 2020). Business managers of automated warehouses using IoT help pharmaceutical companies save 19% of their initial costs.

b) AI integration:

Incorporating AI in pharmaceutical supply chains helps in demand forecasting, predictive maintenance, end-to-end visibility, and smart factory integration (Calatayud *et al*, 2019). AI technologies such as deep learning, machine learning, natural language processing, speech, and supervised learning help in real-time information analysis, monitoring information across the globe and predicting the future with minimum errors (Zemankova, 2019).

The percentage of enterprises implementing AI grew to about 270% in the past four years, and global spending on AI will increase to \$98 by 2023 (Properzi & Cruz, 2020).

Incorporating AI in pharmaceutical supply chains helps in demand forecasting automation, helps optimize predictive maintenance, and protects the integrity of the pharmaceutical supply chain from counterfeit drugs (O'Reilly & Binns, 2019).

c) Cloud computing:

Cloud-based computing helps companies produce and deliver products and services on time, enjoy short lead time, and have lower costs (Giannakis *et al*, 2019). By implementing a cloud-based supply chain, pharma companies can benefit from end-to-end supply chain visibility, better collaboration with other organizations, and optimal decision-making (Ross & Blumenstein, 2015). The use of cloud computing helps supply chains reduce cost, mitigate response time, enhance delivery time, and improve supply chain visibility (Cao *et al*, 2017).

d) Big data analytics:

Big data analytics helps business managers by offering a new perspective and adding value for improving their modeling practices and predictive analysis (Onciou, 2019). It helps companies to reduce costs, understand the end customer better, and manage supply chain uncertainties (Vidgen *et al*,

2017). BDA in the supply chain helps its performance by enhancing visibility, resilience, robustness, and organizational performance (Gunasekaran *et al*, 2017). It results in intelligent supply chains by harvesting data, improving operational efficiency, enhancing customer services, and fostering informed strategic decisions (Zhan & Tan, 2020).

e) Enterprise resource planning:

ERP helps improve connectivity within the supply chain environment (Tongsuksai & Mathrani, 2020). ERP helps managers streamline end-to-end planning, supports transportation and inventory keeping in the warehouse, and offers better visibility on analytics to support better decision-making. ERP applications combine many standalone and disintegrated systems into one application to create a synergistic environment within the organization.

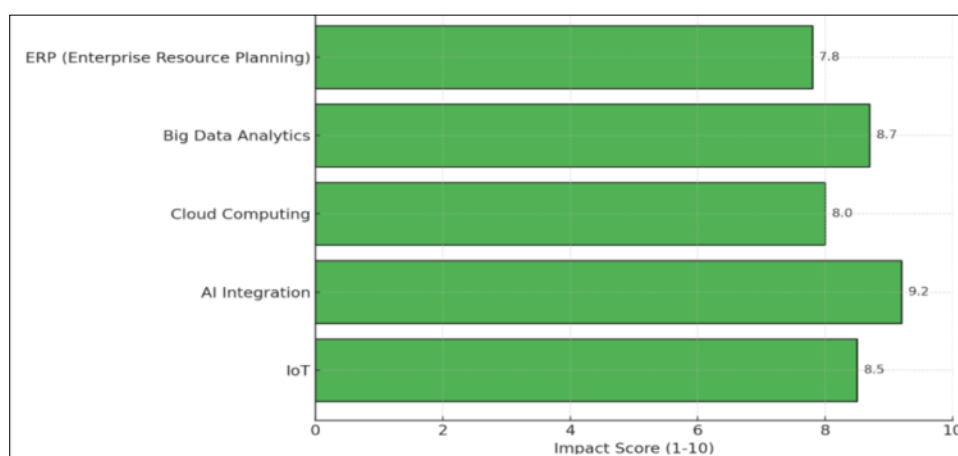


Fig 2: Impact of digital technologies on the pharmaceutical supply chain

A 5-Point Plan for reinventing the pharma supply chain

The pharmaceutical industry is under tight pressure to adapt to a rapidly evolving landscape. This is marked by technological advancements, global disruptions, and increasing patient expectations (McKinsey & Company,

2022). Reorganization of the conventional pharmaceutical supply chains into an agile, inexpensive, and flexible supply chain warrants operational excellence and cost reduction techniques.

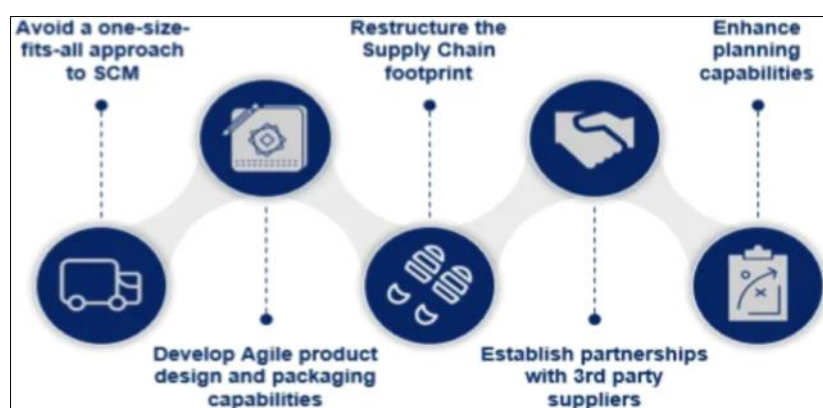


Fig 3: 5-point plan for reinventing pharma supply chains.

a) Do not have a one-size-fits-all supply chain approach

Supply chain standardization should not be the case for pharmaceutical organizations, but segmentation, along with product profiles and service requirements, should be adopted.

According to Chopra and Meindl (2019) ^[1], a supply chain that does justice under such a definition-dimension of product life cycle, demand variability, and value density is most likely to be the best answer to customer service and operational efficiency.

b) Establish agile capabilities for product design and packaging

Agile product designing and late-stage packaging are very important in strengthening the response to regional legislation and patient-specific needs. According to Mehrjoo and Pasek (2020) ^[6], agility in packaging operations enables rapid customization. It has the potential to reduce lead times and improve time-to-market for personalized therapies and localized product variants.

c) Realigning the supply chain footprint

Now, pharmaceutical companies redesign their global manufacturing and distribution supply chain for agility while reducing disruptions to supply. Ivanov & Dolgui (2020) ^[4] state that such diversification across the network and nearshoring strategies will have very significant impacts on supply chains as they build resilience against geopolitical risks and pandemic shocks. A geographically distributed supply network ensures that a company does not rely too much on single-source suppliers while improving continuity.

d) Joint ventures with third-party suppliers

the third-party logistics contract manufacturers deepen the strategic fit of the partnership to achieve scalability and flexibility. Christopher 2021) ^[2] indicated that non-core functions should be outsourced to specialized third parties,

thereby saving costs and acquiring global capabilities so as to adapt quickly to changing market demand patterns. It also creates an opportunity for innovation through speedier access to the market.

e) Upgradation of planning capabilities

Advanced supply chain planning ensures more accurate forecasting and real-time decision-making, thanks to predictive analytics and digital technologies. According to Ghosh (2021) ^[3], AI-based planning tools improve visibility, lessen inventory waste, and facilitate a better response rate. The integrated planning systems allow the company to simulate supply scenarios and optimize end-to-end operational performance under uncertainty.

Digital transformation in pharma supply chain - market growth and insights

Digital transformation is reshaping the pharmaceutical supply chain, bringing about a new era of automated, data-driven, and agile operations. The global market for digital transformation in pharmaceutical supply chains is expected to grow from USD 3.2 billion in the year 2022 to USD 8.9 billion in the year 2027. This growth marks a CAGR of 22.1% and is driven by the adoption of digital tools like AI, ML, cloud computing, IoT, etc., across the supply chain ecosystem.

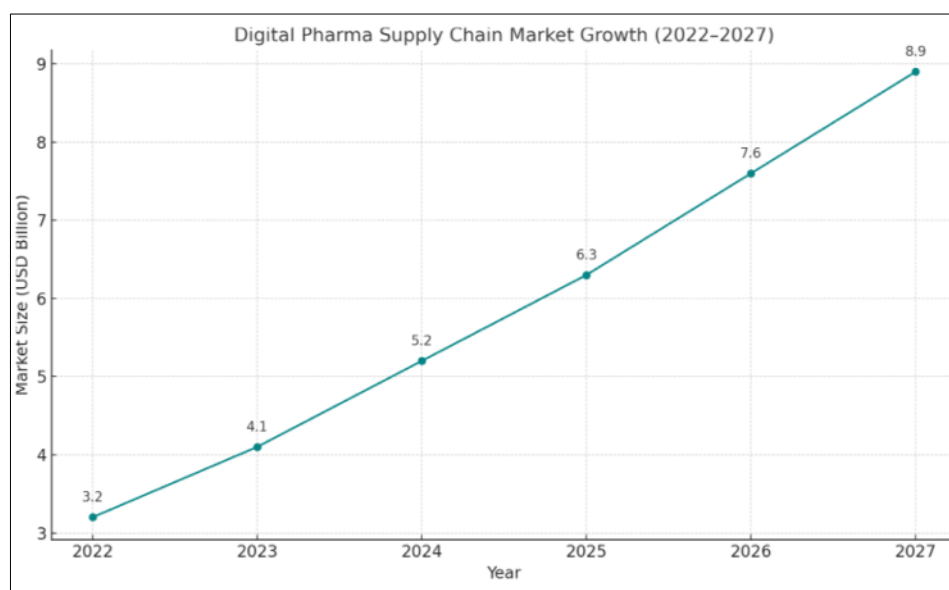


Fig 4: Pharmaceutical supply chain market growth after digitalization.

The areas where transformation is likely to occur include real-time visibility, intelligent planning systems, smart warehousing, and end-to-end traceability (Ghose, 2021). These innovations include flexibility improvements, reduced outages, improved inventory levels, and accuracy in demand forecasting.

AI, digital twins, and machine learning will play a pivotal role in shaping the pharma supply chains. These technologies will allow pharma companies to analyze the data sets, identify supply disruptions, and optimize processes before implementation (Ivanov & Dolgui, 2020) ^[7].

Blockchain adoption will revolutionize pharmaceutical traceability and compliance to ensure tamper-proof drug tracking. The adoption of cloud-based platforms helps to

integrate across manufacturing sites, distributors, and suppliers. In short, pharma companies that invest in digital capabilities enjoy better efficiency, service, and a resilient supply chain.

Recommendations

The current study highlights the transformative potential of digital technology in the pharmaceutical supply chains. It is worth conducting empirical research to explore the benefits brought by AI, digital twins, and blockchain technologies with respect to performance metrics such as lead time reduction, cost efficiency, and service level improvements within the context of the pharmaceutical supply chain.

Further research needs to be focused on longitudinal case

studies and quantitative modeling of all these technologies to understand their effectiveness in relation to other geographic and regulatory settings.

Sustainability is yet to be researched as an emerging digital supply chain theme. Investigating the role of digital tools would benefit students in discussing how they can be involved in developing a circular supply chain model, reducing waste, and diminishing the carbon footprint for pharmaceutical logistics.

Research should also deal with the human and organizational dimensions of digital transformation, like employee skill gaps, digital literacy, and resistance to change. Then, multidisciplinary perspectives, including technology, operations management, and behavioral science, will provide much richer knowledge of future innovations affecting supply chains.

Conclusion

The supply chain in the pharmaceutical industry plays a crucial role in enhancing the health of society. This reveals the importance and distinction of this supply chain compared to the supply chains of other industries (Mahani *et al.*, 2018). This industry faces a number of challenges, both internally and externally. It has risks in the production, warehousing, and transportation process and is also susceptible to the needs of the end customer, government regulations, geopolitical events, etc. Business leaders of pharma companies can use emerging digital technologies, such as AI, cloud computing, IoT, etc. to manage and mitigate these challenges and improve the performance of pharmaceutical supply chains. The paper also discussed the 5-point approach for pharma companies to follow in order to keep such risks in check. Supply chain digitalization initiatives will definitely make pharmaceutical processes sustainable, successful, and resilient.

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