



REVIEW ARTICLE

ARTIFICIAL INTELLIGENCE: A GAME CHANGER IN PHARMACEUTICAL MANUFACTURING 4.0

Fatima Mendoza, Kazandra Ruiz Colon and Sunita Dahiya*

Department of Pharmaceutical Sciences, School of Pharmacy, University of Puerto Rico - Medical Sciences Campus, San Juan, PR 00936, USA

*E-mail: sunita.dahiya@upr.edu
Tel.: +1 (787) 758 2525 Ext.5413.

Received: Oct 20, 2024 / Revised: Nov 13, 2024 / Accepted: Nov 14, 2024

Artificial Intelligence (AI) is making significant changes in numerous healthcare sectors around the world. Being an essential component of healthcare, the pharmaceutical industry is also not behind in utilizing AI's vital role at various phases of the drug development process. Specifically, AI can be utilized at various stages of pharmaceutical research and manufacturing starting from drug discovery to several tasks involved in manufacturing operations ranging from quality control to packaging, including product tracking from beginning to end. AI plays a vital role in enhancing the complex manufacturing of biopharmaceuticals by optimizing processes in real time, monitoring cell health, and employing predictive analytics. By improving visibility, efficiency, and compliance, AI can lead to smarter manufacturing processes, superior quality products and efficient supply chain solutions. In addition, AI has a critical role to play in achieving temperature-controlled distribution of biopharmaceuticals, supply chain management, prediction of potential issues and patient-focused solution creations helpful in personalized medicine. However, there are still several challenges that need to be addressed before fully integrating AI into manufacturing operations at all levels. This article reviews the potential of AI in pharmaceutical manufacturing, highlighting its benefits, recent breakthroughs and major challenges in its full implementation. The article also discusses the prospects of AI and suggests solutions to overcome real time limitations associated with full implementation of an AI-integrated pharmaceutical manufacturing and research efforts within the industry and academic settings.

Key words: Artificial intelligence, Innovative manufacturing, Automation, Drug development.

INTRODUCTION

In present times, the pharmaceutical industry is undergoing a significant transformation which is largely driven by advancements in artificial intelligence (AI). Traditionally, the process of manufacturing pharmaceuticals has been intricate and subject to rigorous regulations, which can often lead to inefficiencies and high costs. However, the integration of AI technologies is revolutionizing this sector, enabling companies to navigate the complexities of drug production more effectively than ever

before [1, 2]. AI plays a pivotal role in enhancing manufacturing processes by automating routine tasks, optimizing supply chains, and enabling real-time monitoring of production activities. For instance, AI algorithms can analyze vast amounts of data to predict equipment failures before they occur, thereby reducing downtime and increasing overall production efficiency. This proactive approach not only improves the reliability of the manufacturing process but also enhances the quality of the final products,