

Application of Artificial Intelligence in Pharmaceutical Manufacturing and Operations: Enhancing Process Efficiency, Quality Control, and Regulatory Compliance

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ABSTRACT

In order to solve concerns pertaining to operational inefficiencies, process unpredictability, and quality assurance, the pharmaceutical manufacturing industry is increasingly turning to solutions that are driven by artificial intelligence (AI). Process analytical technology (PAT), predictive maintenance, quality by design (QbD), and supply chain management are the primary subjects of this study, which studies the application of artificial intelligence and machine learning algorithms in the pharmaceutical manufacturing process and the optimization of operational procedures of pharmaceutical manufacturing AI based models, such as artificial neural networks, random forest algorithms, and deep learning techniques, are utilized to analyse large-scale manufacturing data. The integration of artificial intelligence with advanced sensors and production execution systems provides improved decision-making, a reduction in the number of batch failures, and the detection of deviations at an earlier stage. Image analysis and pattern recognition technologies that are assisted by artificial intelligence also improve quality control because they make it easier to quickly identify defects in solid dosage forms and packaging procedures. It is possible to schedule maintenance on equipment with the assistance of predictive analytics, which also helps to reduce downtime and improve overall equipment efficiency. Concerns around cybersecurity, model validation, data quality, and regulatory approval continue to be key problems, despite the fact that it has a number of advantages. The study focuses on how the application of artificial intelligence in pharmaceutical manufacturing can result in production systems that are more intelligent and independent. This is accomplished by greatly enhancing the efficiency with which operations are carried out, the quality of goods, and compliance with laws.

Keywords: Artificial Intelligence, pharmaceutical manufacturing, process optimization, quality control, predictive analytics, PAT.

