Chapter 5
Improving the Operational Efficiency of Healthcare Operations Using Digital Twins

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ABSTRACT

The adoption of digital twin technology in healthcare signifies a groundbreaking approach to enhancing operational efficiency and patient care. This chapter explores the transformative impact of digital twin technology in healthcare, which uses virtual replicas of physical assets to enhance operational efficiency and patient care. It covers the foundational principles, including architecture, components, and examines their application in predictive maintenance of medical equipment, real-time patient monitoring, and hospital management. Through case studies and examples, the chapter illustrates how digital twins forecast equipment failures, reduce downtime, and optimize resource allocation, leading to cost savings and improved patient outcomes. Additionally, it discusses the integration of digital twins with IoT, AI, and big data analytics, highlighting its role in advancing patient care. Challenges like data privacy and technical complexities are addressed, emphasizing the potential to revolutionize healthcare systems for greater efficiency and patient-centric care.

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INTRODUCTION

Digital twins are the next big thing in fourth industrial revolution for the development of new products and processes. This technology can significantly transform modern health care and other business spheres to create digitized counterparts of actual items is Digital Twins. It means creating an imitation of an object, process, or system that exists in real life for modelling and analysis and improvement with the help of digital media. This technology, which was initially used in aerospace and manufacturing sectors, is now revealing a rising survival in fields relating to health care. A digital twin is, therefore, a wide definition pointing to a digital mirror image of an object, system or process and which is capable of assimilating actual time data and delivering the insightful data. These digital counterparts are created by using sensors, big data, AI, and ML algorithms in the formation of its structure (Chauhan et al, 2003). A digital twin operates as close representations of the physical systems by acquiring data and then using analytical models to provide an actual picture of them. This technology is to not only supervise and regulate the physical assets but also applied for predicting the failure, governing the processes and for planning the regulating strategies. As it concerns the use of a digital twin in health care, the future of managing medical establishments is going to be transformed, as integrated solutions will enhance the efficiency of healthcare facility in terms of adaptability, individual focus on the patient, and the sparing usage of resources. In health care where issues to do with efficiency of the health care equipment as well as the quality of the health care services being offered are of so much importance. (Tao et al.,2019) pointed out real time monitoring and prediction by DTs as a complex endeavoured advancement that enhances actual – time decision-making process in healthcare and other related disciplines. Therefore, to gain insight into digital twin technology, it is essential to comprehend its elements and operations that it plays. Crucially, a digital twin assimilates data from the physical counterpart a digital twin is made of, like sensors, EHRs, and IoT in a real time updated model of a physical object or process. It is continually updated with the current conditions of the physical system that it is modelling, and the digital twin. The information is then subjected to further analytical and artificial intelligence analysis to yield insights and forecasts about the various processes. For instance, in the healthcare sector, digital twins can reflect the functioning of a hospital, from the workflow of patients to the distribution of supplies and people (Mohamed et al.,2023). It can model various conditions, for instance, times when many patients troop in due to flu season and identify some constrains. Moreover, digital twins can be implemented to establish patient-specific emulation to aggregate information from several medical devices and records for real-time tracking of health conditions and forecasting of potential health events. This is why the digital twin technology that has the ability