

Predicting hospital efficiency through integrated Data Envelopment Analysis and machine learning

Health systems are under growing pressure due to resource constraints and increasing demand. Measuring hospital efficiency is therefore crucial to support effective management and evidence-based policymaking. This study introduces an innovative framework that combines Data Envelopment Analysis (DEA) with machine learning (ML) techniques to assess and predict the efficiency of Portuguese public hospitals. Efficiency scores were obtained using the Super Efficiency Slacks-Based Measure DEA model, applied to a ten-year dataset from 2014 to 2023. Results indicate that 76.82% of hospital units operated inefficiently, with marked disparities across regions, particularly in the south and interior areas. To enhance the model's predictive capacity, ten ML algorithms were evaluated, with XGBoost achieving the highest accuracy. The integrated SuperSBM-DEA and XGBoost model enables the simulation of improvement scenarios for underperforming hospitals and anticipates the efficiency impact of managerial decisions. Beyond its predictive performance, the framework offers actionable insights and holds strong potential for integration into national healthcare policy. The findings suggest the feasibility of a centralised, data-driven system for dynamic resource allocation, contributing to a more equitable and efficient provision of care across regions.

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