

AI-powered predictive modeling and comparative machine learning analysis for improving hospital operational efficiency

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The study addresses the critical problem that Sri Lankan state-run hospitals have no data-driven predictive tools of patient movement and resource allocation that have led to longer patients waiting and poor bed utilization. This study was done in the face of problems such as long patient waiting time and ineffective bed management owing to manual operations. The study followed an organized machine learning pipeline, where 500 records of patients from 01/2023 to 12/2023 were used to train and test predictive models that would predict Length of Stay, Readmission and Resource Requirement. The most important algorithms were the Random Forest, Gradient Boosting, and XGBoost, and they were tested according to the cross-validation and hyperparameter optimization. Findings confirmed that XGBoost was superior to the other models in that it was able to manage the complex interactions between features effectively and the test accuracy of 82.7% with F1-score of 0.809 indicating readmission prediction. Whereas, the Mean Absolute Error of the model in predicting length of stay (LOS) was approximately 9 days against a mean LOS of 15 days. It was also found that clinical and demographic factors such as Infection condition type, age group to 41-60, and department Intensive Care Unit are the most powerful predictors due to feature analysis, which indicated that the clinical presentation and patient characteristics were stronger indicators of the decision-making process of bed management than administrative characteristics. This study has shown that decision-support systems can be utilized based on solid ground using AI predictive models to optimize work processes in resourcelimited healthcare environments.

Keywords: *Artificial Intelligence; Healthcare Resource Optimization; Predictive Modelling; Patient Flow Management; Machine Learning*