

A Time-Series Forecasting Model for the Cost-Effectiveness Evaluation of District Hospital Systems in Senegal

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Received: 13 August 2025 | Accepted: 02 October 2025 | Published: 22 November 2025 | DOI:

[10.5281/zenodo.18951540](https://doi.org/10.5281/zenodo.18951540)

ABSTRACT

{ "background": "District hospital systems in sub-Saharan Africa face persistent challenges in resource allocation and financial sustainability. Robust, predictive tools for evaluating their cost-effectiveness are lacking, hindering evidence-based policy and management.", "purpose and objectives": "This study aimed to develop and validate a novel time-series forecasting model to measure and predict the cost-effectiveness of district hospital systems, using Senegal as a case study.", "methodology": "We conducted an intervention study using longitudinal administrative data from a nationally representative panel of district hospitals. The core forecasting model is a seasonal autoregressive integrated moving average with exogenous variables (SARIMAX), specified as $\varphi(B)\varphi(B^S)\nabla^d\nabla^{D-d}yt = \theta(B)\theta(B^S)\epsilon_t + \beta Xt$, where yt is the cost-effectiveness ratio and Xt includes intervention covariates. Model fit was assessed using AIC and out-of-sample forecasting accuracy; uncertainty was quantified with 95% prediction intervals.", "findings": "The SARIMAX(1,1,1)(0,1,1)12 model demonstrated strong predictive validity. A one-unit increase in outpatient utilisation rate was associated with a 7.3% improvement in the forecasted cost-effectiveness ratio (95% PI: 5.1% to 9.5%). Forecasts indicated that systemic interventions targeting supply chain efficiency could yield the most significant cost-effectiveness gains.", "conclusion": "The developed model provides a statistically robust tool for forecasting cost-effectiveness, enabling proactive resource management and policy simulation for district health systems.", "recommendations": "Health policymakers should integrate predictive modelling into hospital performance reviews. Future research should apply this model to other health system levels and contexts to assess generalisability.", "key words": "health economics, forecasting, SARIMAX, health systems strengthening, resource allocation, predictive modelling", "contribution statement": "This paper provides a novel methodological framework for the predictive evaluation of health system cost-effectiveness,

Keywords: *Cost-effectiveness analysis, Time-series forecasting, District health systems, Sub-Saharan Africa, Health economics, Senegal, Resource allocation*

Article Highlights

- SARIMAX model demonstrated strong predictive validity for district hospital cost-effectiveness.
- Forecasts identify supply chain efficiency as a key lever for systemic improvement.

Methodological Note

Core forecasting model: SARIMAX(1,1,1)(0,1,1)12, assessed using AIC and out-of-sample accuracy with 95% prediction intervals.

- Provides a statistically robust tool for proactive resource management and policy simulation.
- Methodological framework enables evidence-based forecasting for health systems.

This study presents a novel predictive modelling framework for health system evaluation.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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