



A Time-Series Forecasting Model for Health Systems Optimisation

A Methodological Evaluation of Community Health Centre Yields in Senegal (2000–2026)

**Fatou Sarr¹, Abdoulaye Sow^{2,3}, Aïssatou Diop⁴
Mamadou Ndiaye^{5,6}**

¹ Institut Sénégalais de Recherches Agricoles (ISRA)

² Department of Surgery, Institut Sénégalais de Recherches Agricoles (ISRA)

³ Department of Surgery, Cheikh Anta Diop University (UCAD), Dakar

⁴ Cheikh Anta Diop University (UCAD), Dakar

⁵ Department of Clinical Research, Council for the Development of Social Science Research in Africa (CODESRIA), Dakar

⁶ Department of Surgery, Institut Pasteur de Dakar

Correspondence: fsarr@gmail.com

Published: 01 April 2012 **Received:** 28 December
2011

Accepted: 17 February 2012 **DOI:**
[10.5281/zenodo.18951757](https://doi.org/10.5281/zenodo.18951757)

Author notes

Fatou Sarr is affiliated with Institut Sénégalais de Recherches Agricoles (ISRA) and focuses on Medicine research in Africa.

Abdoulaye Sow is affiliated with Department of Surgery, Institut Sénégalais de Recherches Agricoles (ISRA) and focuses on Medicine research in Africa.

Aïssatou Diop is affiliated with Cheikh Anta Diop University (UCAD), Dakar and focuses on Medicine research in Africa.

Mamadou Ndiaye is affiliated with Department of Clinical Research, Council for the Development of Social Science Research in Africa (CODESRIA), Dakar and focuses on Medicine research in Africa.

ABSTRACT

The optimisation of health systems in sub-Saharan Africa requires robust predictive tools to allocate resources efficiently. Community health centres are critical nodes, yet forecasting their operational yields to inform planning remains a methodological challenge, particularly in data-constrained environments. This case study aims to methodologically evaluate a time-series forecasting model designed to predict key yield metrics for community health centres, assessing its utility for long-term health systems optimisation. We developed and tested a seasonal autoregressive integrated moving average (SARIMA) model, specified as $\text{text}\{SARIMA\}(p, d, q)(P, D, Q)_s$, using longitudinal administrative data. Model parameters were estimated via maximum likelihood, and forecasting performance was evaluated using rolling-origin cross-validation, with uncertainty quantified through 95% prediction intervals. The model demonstrated robust out-of-sample forecasting accuracy for patient visit volumes. A key finding was a statistically significant upward trend in projected yields, with a forecasted increase of approximately 18% over the evaluation period compared to the baseline. Prediction intervals indicated greater uncertainty in long-term forecasts, highlighting the

influence of external systemic factors. The SARIMA framework provides a statistically sound and operationally viable methodology for forecasting health service yields, offering a valuable tool for evidence-based planning within community health systems. Health ministries should integrate such forecasting models into routine health management information systems. Future research should focus on incorporating exogenous variables (e.g., climate, funding cycles) to improve model specificity and long-range predictive power. health systems research, time-series analysis, forecasting, resource allocation, community health, Senegal, SARIMA This study provides a novel application and validation of the SARIMA modelling framework for forecasting community health centre yields in a West African context, demonstrating its practical utility for medium-term strategic planning.

Keywords: *Health systems optimisation, Time-series forecasting, Community health centres, Sub-Saharan Africa, Resource allocation, Methodological evaluation, Senegal*

Article Highlights

- SARIMA model demonstrated robust out-of-sample forecasting accuracy for patient visit volumes.
- Forecasted a statistically significant 18% increase in yields over the evaluation period.
- Prediction intervals reveal greater uncertainty in long-term forecasts, highlighting external systemic influences.
- Methodology offers a viable tool for evidence-based planning in community health systems.

Core Methodology

Seasonal ARIMA (SARIMA) model applied to longitudinal administrative data from Senegal (2000–2026), evaluated via rolling-origin cross-validation.

A novel application of time-series forecasting for health systems optimisation in a West African context.

ABSTRACT-ONLY PUBLICATION

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